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May, 1961

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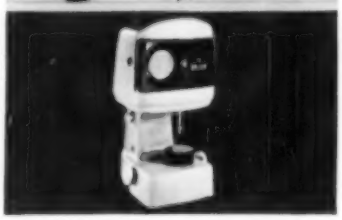

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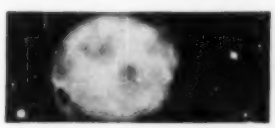
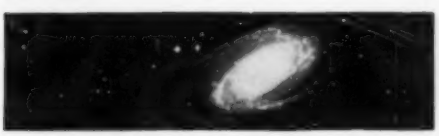


Bell Laboratories research with chilled ruby amplifiers speeds the day we may telephone via satellites



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INDUSTRIAL QUALITY CONTROL

Vol. XVII, No. 11 May, 1961

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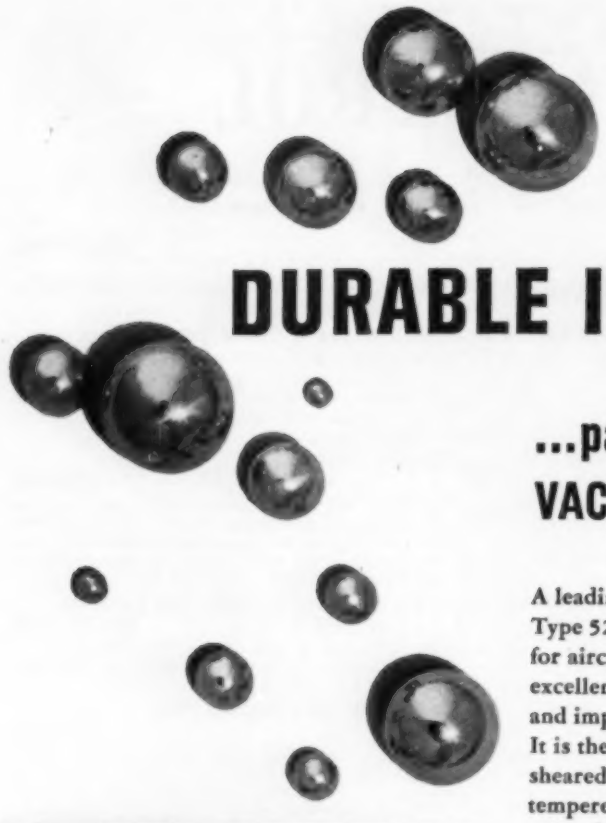

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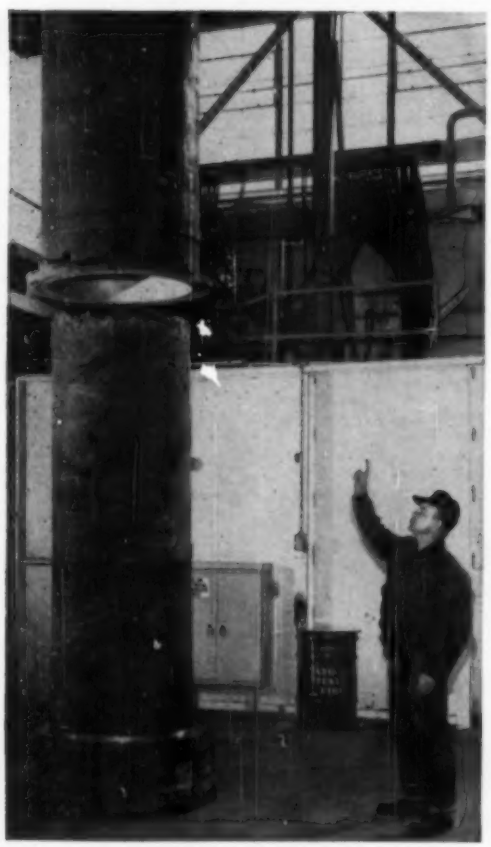

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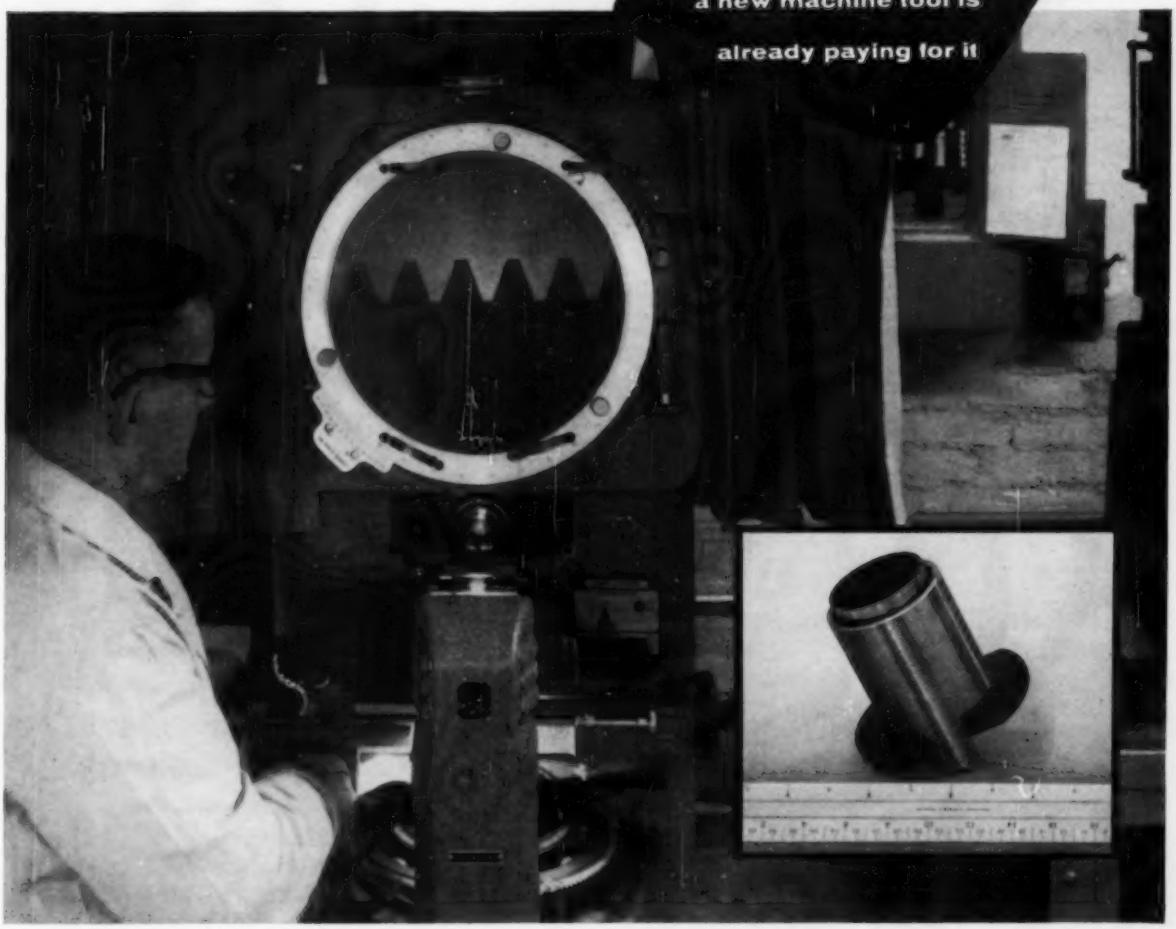

Unretouched photo (above) shows this cylindrical rack being inspected at 62.25X. Photo, courtesy of Baird-Atomic Inc., Cambridge, Mass.

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From the President's Desk

Policy Statement on Professional Certification

The General Professional Council was established to determine what activities the Society needs to offer its members to enable them to grow professionally. The long-term goal of the program is to achieve recognition of quality control as a professional discipline by the industrial community it serves. At the outset it was apparent that any such professional recognition on a general scale must be earned by the collective effect of the actions of individual members. Accordingly the Council's efforts have been directed toward planning overall programs by which individual members of ASQC may grow in professional competence and hence stature.

Professional Certification Program

One such program which the Council is now proposing is the establishment of "professional certification." Professional certification, like the licensing and certification activities of other professional groups, is envisaged as a series of professional grades. Each successively higher grade will certify that the member holding it has the proficiency to perform quality control work of an increasingly difficult professional level.

The professional grades are to be earned by a member independently of the present membership grades specified by the constitution of ASQC. These present membership grades specify only minimum requirements as to education, age and amount (or time) of experience. It is the purpose of the professional grades to go beyond these requirements and certify as to the member's ability or proficiency in performing work at a given professional level. Ultimately it is planned to merge the time and experience requirements of the membership grades with the performance requirements of professional certification into a single, unified system.

Certification Standards

Before professional certification is feasible it is necessary to establish professional standards of performance against which individual performance can be measured. As a first step in establishing such standards, it has been necessary to delineate the nature of quality control work. This has been accomplished in the paper, Basic Work Elements of Quality Control Engineering, and appears on page 8 of this issue.

Method of Certification

With these work elements delineated, the standards for professional grades will now be established. It is proposed that for the first two years certain senior and fellow members qualified on the basis of education and experience could obtain professional certification without a written examination. Others would obtain certification on the basis of oral examinations. Later suitable written examinations will be developed which will take into account the various special disciplines of quality control work.

Eventually it is planned that courses of instruction will be offered by the Education and Training Institute which will enable a member to prepare himself for these examinations.

To administer the professional certification program, it is recommended that a Certification Committee be established whose duties would parallel those of the Examining Committee with respect to advancement through the membership grades.

Jy McClure

The BASIC WORK ELEMENTS Of Quality Control Engineering

GENERAL PROFESSIONAL COUNCIL
American Society for Quality Control

Introduction

This article represents an effort to provide a statement covering the basic Work Elements of Quality Control Engineering. It was prepared by the Committee for Development of Basic Work Elements under the direction of the General Professional Council of the American Society for Quality Control.

An effort has been made to be very general in order that the document would be directly applicable to a broad variety of industrial and governmental situations. Material which would have been of value in describing work elements in some areas has been omitted if it detracted from the general validity of the document.

It is emphasized that this document is restricted to the engineering aspects of control of quality. Other occupational areas in the Quality Control field are not covered, although they may include some of the elements appearing in this document.

The Basic Work Elements is designed to serve as the foundation for building the professional stature of our society. It provides a much needed guide for Quality Control Engineers and Industrial Managements in establishing and guiding their quality control programs. Colleges and Universities will, no doubt, utilize this information in the development of future curricula.

A Broad Definition of QC Engineering Activities

The ultimate objective of all Quality Control (QC) endeavor is to provide quality assurance for the finished product and to assure optimum quality costs for that product. To accomplish this objective, every producer needs an integrated program for the control of product quality including its reliability elements comprising the basic work elements described herein. The totality of the work elements is not, of course, intended to describe the work of any single QC Engineer, nor the work of any particular QC Organization. A QC Engineer may specialize in only one or a few of these elements and still be performing legitimately professional work. QC Engineering encompasses the planning, the control, the evaluation, and the reporting of all quality aspects of the product from its conception through manufacture, processing, storage, delivery, installation, maintenance, and repair to the end of its service life.

All the functions of an organization have specific responsibilities for product quality. QC Engineering does not seek to usurp any of these functions. However, it does afford an effective means of providing each supervisor and engineer with specific and overall quality and cost views to enable him to make decisions leading to optimum product cost and quality.

In like manner, of course, all functions of an organization contribute to the reliability elements of product quality. Ultimate reliability cannot exceed that which is designed into the product. Continued achievement of the design reliability is dependent upon strict control of all material and process characteristics which maintain the integrity of the design. Logically, therefore, those activities related to product reliability are appropriately reflected in all the principle work areas of the Basic Work Elements.

In the new design area, QC Engineering aids in the development and analysis of new products and processes, and works to eliminate future quality problems. Economical incoming material control procedures, which include supplier process controls, are the responsibility of QC Engineering. In-plant process and product control and evaluation and assurance of the quality and reliability of finished goods are also prime QC Engineering responsibilities. Finally, QC Engineering includes evaluation of in-process, finished, and field inventories. All of these elements make up the hard core of QC Engineering.

The activity which ties together and directs the planning, control, evaluation, and reporting of all the quality aspects of the production task is truly engineering. It is characterized by creative work. Statistics, technical process and product knowledge, and practical shop experience are combined in attaining the goal of optimum quality product at lowest possible cost.

ASQC LCS Code 000:00:000

General QC Engineering

Certain work elements of QC Engineering are general in nature and have application in all phases of the QC job. Regardless of the area of his specialization, several or all of the following elements comprise an important part of the QC Engineer's job.

1. *Training* Prepare current educational material for conducting training programs in all aspects of quality control including Statistical Quality Control (S.Q.C.). Train at all levels of the organization. Keep abreast of new developments in the field for purposes of training and application.
2. *Quality Standards* Develop and implement quality standards where needed in the organization. Train members of the organization in their use.
3. *Measurement and Analytical Facilities* Determine, recommend, and/or design measurement and analytical facilities required to make evaluations of product quality and reliability. Develop and maintain an economic program for periodic precision and accuracy checks, for calibration and for maintenance of all jigs, fixtures, physical testing, measurement, and analytical facilities.
4. *Methods and Procedures* Develop forms and instructions to be used for collecting, analyzing and reporting quality and reliability data. Institute procedures for identifying responsibility and for implementing corrective action.
5. *Discrepant Material* Establish and implement clear concise procedures for the disposition of discrepant material. Determine responsibility and the proper allocation of extra costs involved.
6. *Audit of the QC Program* Provide methods and arrange for auditing and reporting the implementation, effectiveness, cost, and savings of the QC Program.

New Design QC Engineering

Quality Control Engineering activities in the new design field thread through all the preproduction activities from conception of the product to trial runs. Application of QC Engineering effort in this phase of the job means improved, less costly product incorporating all the knowledge obtained from previous designs or research. Quality Control Engineering will minimize process control problems from the day production begins. Several or all of the following specific activities are involved in this area.

1. *Product and Process Research* Conceive and analyze designed experiments and tests to gain further knowledge of the variables affecting component, product, and process quality and reliability. Devise means of evaluating other manufacturer's designs. Analyze and report results.
2. *Specifications* Prepare and present data summarizing field, manufacturing and vendor complaints on previous designs. Recommend to design engineering specifications which will eliminate these problems from the new design.
3. *Tolerances* Use statistical methods to predict overall tolerances of proposed designs based on previous process capability studies. Submit to design engineering tolerance recommendations which enable desired overall tolerances to be met and at the same time allow individual dimension tolerances to be within process capabilities.
4. *Initial Samples* Plan tests, inspections, and statistical studies on initial product samples. Analyze results to verify realization of design quality and reliability objectives.
5. *Methods Of Achieving Quality Production* Recommend to production engineering process improvements including fixtures, tools, jigs, inspection, and testing devices required to achieve process control and maintain desired quality and reliability.
6. *Final Design Analysis* Analyze tolerances, specifications, and dimensions of final design to assure that the product can be manufactured as planned. Make recommendations to design engineering on tolerance problems for possible modification.
7. *Trial Runs* Determine parameters of trial lots to be measured and controlled. Analyze results. Predict the performance of future production lots. Prepare a report of trial data for design engineering and for a permanent record.
8. *Control of Production Lots* Summarize all the information learned in Steps 1 to 7 and make recommendations for use in establishing economical methods of measuring and controlling production.

Incoming Material QC Engineering

The control of overall product quality is inseparably linked with the quality of purchased material. QC Engineering, therefore, has a contributing responsibility in the selection of suppliers and a direct responsibility for economic control of the quality of incoming materials and for providing evaluation and feedback to other functions to assure the procurement of quality materials at the most favorable cost. The following QC Engineering functions provide for the accomplishment of this objective.

1. *Supplier Capability* Evaluate supplier quality performance capability and develop quality performance ratings for use by Purchasing in their selection and development of material suppliers.
2. *Quality Requirements* Provide suppliers, through Purchasing, with clear, concise quality and reliability requirements. Follow up to assure adequate understanding and supplier action to meet these requirements.
3. *Certification* Work with suppliers to establish quality certification plans based on adequate procedures and controls at suppliers' plants to minimize the cost of assuring the quality of incoming materials.
4. *Inspection Methods* Develop, install, and maintain inspection and analytical procedures including economical sampling plans to determine the quality level of incoming material. Insure compatibility of these procedures between supplier and incoming inspection.
5. *Documentation and Feedback* Establish and monitor systems for recording and reporting supplier conformance to quality and reliability requirements.

Process QC Engineering

Utilizing statistical, engineering, and administrative QC methods, develop, install and maintain economic process controls to achieve and retain process capabilities. The objective of these controls is to maintain operating costs while product quality is

retained or improved to acceptable standards. The following are several specific techniques QC Engineers may use to accomplish process control.

1. *Capability Studies* Make capability studies of production equipment and processes. Determine the measurements to be taken, the analysis of data, and the action to correct undesirable conditions.
2. *Process Controls* Establish measurements and process controls to maintain economic control, and to detect entry of any factors that might adversely affect product quality or reliability. Provide adequate written and verbal instructions to personnel performing process control activities.
3. *Periodic Review* Review process controls periodically to adjust for changing conditions and to minimize process control costs.
4. *Trouble Shooting* When out-of-control conditions develop, assist operating and engineering personnel to identify and eliminate causes, using statistical techniques where applicable.
5. *Designed Experiments* When either quality or cost of a controlled process is unsatisfactory, design and conduct experiments to point out process improvements and desirable changes of product specifications. Recommend or authorize changes necessary to effect improvement.

Product Evaluation QC Engineering

Develop, install, and maintain inspection practices and product evaluation procedures to insure that only acceptable quality product is shipped. To accomplish this objective, QC Engineering activity should encompass the following functions.

1. *Inspection Methods* Develop, install, and maintain inspection and analytical procedures to determine the quality level and permit the acceptance of satisfactory product. Insure compatability of these procedures between process and product acceptance.
2. *Sampling Plans* Develop and implement economic sampling plans and procedures.
3. *Feedback* Provide for both routine and special feedback and analysis of inspection results so that corrective action can be taken when necessary.
4. *Quality Levels and Defect Classifications* Develop and implement quality levels and appropriate defect classifications for quality rating of completed product and associated packaging compatible with consumer requirements and capabilities of the production processes.
5. *Auditing* Develop and install methods and procedures for auditing, evaluating, certifying and reporting the quality and reliability of product shipped.
6. *Complaints* Analyze customer complaints and field reports. Identify causes and responsibility, and initiate corrective action.

Inventory Evaluation QC Engineering

The deterioration of materials and finished products in use or in storage is an important problem to both producers and users. Economical, reliable evaluation, factual analysis, and engineering judgment applied to inventory quality problems provide management with deterioration curves, maintenance requirements, and feedback information to maximize life. These functions of QC Engineering minimize costs and maximize life. These functions of QC Engineering minimize costs and maximize product serviceability.

1. *Sampling* Apply economical statistical sampling procedures to appraise inventory quality.
2. *Quality Projection* Using the results of periodic samples, establish and interpret deterioration curves to enable management to maintain desired levels of acceptable quality stocks.
3. *Feedback* Based on sampling results, provide feedback to design, purchasing, and production which will aid in maximizing inventory serviceable life.
4. *Process Controls* Provide and implement process controls for repair, maintenance, reprocessing, and disposition of materials and products in inventory or service.
5. *Management Inventory Policies* Recommend on the basis of inventory quality and reliability history, those inventory policies which will result in optimum quality and cost of maintaining serviceable materials or products.

Special Studies and Activities of QC Engineering

Under this heading fall those work elements which will result in wider and more complete use of SQC techniques. General in nature and not directly connected with day-to-day quality problems, they should nevertheless, be part of every QC Engineer's responsibilities.

1. *New Techniques* Develop new techniques and approaches for the analysis of quality problems.
2. *Special Studies* Assist in applying SQC methods and principles to other management functions such as Operations Research, Safety, Finance, and other administrative applications.
3. *Advancement of QC Engineering* Promote the objectives and applications of SQC through activity in professional organizations. Contribute to the advancement of QC Engineering through the preparation of technical papers for presentation at meetings, seminars, and conventions, and for publication in company and national magazines and books.

Basic Work Elements Committee Members

Chairman — G. A. Endrich, Heavy Military Electronics Department, General Electric Co., Syracuse, N.Y.

R. Schin, Western Electric Co., Grandview, Mo. Mr. Schin was chairman of the committee from its inception in October, 1958, to September, 1960.

S. L. Carrell, Special Computer Devices, Texas Instruments. Inc., 6000 Lemmon Ave., Dallas, Texas.

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The committee reported to Dr. A. V. Feigenbaum, vice president for professional development, American Society for Quality Control.

Developing QUALITY Consciousness

. . . it's up to you!

RALPH T. SOULE

Elliott Service Co., Inc., Mount Vernon, N. Y.

AN EVER PRESENT DANGER to every quality program is that it will become shipwrecked on the rocks of employee indifference.

This apathy, this lack of caring, this neither-for-nor-against attitude of employees concerning quality can exist in any plant, irrespective of size or type of product manufactured. It poses today's greatest single and continuous threat to the successful operation of a quality control program. It is a barrier that must be broken and therein lies a challenge management cannot afford to ignore. Retaining or improving your company's competitive position can well depend on the degree of success your quality program enjoys. Quality production is not a luxury—it is a necessity!

The quality control manager performs a vital function in every company. The scope and importance of his responsibility has grown enormously in recent years—and so have his problems! Beyond the exacting and time-consuming technical aspects of his work, forever looms the formidable task of convincing tens or hundreds or thousands of individual employees that quality is important. Here is where management, by virtue of a common interest, can and should encourage, assist and sustain his efforts to the fullest.

Now, quite obviously, all of us in ASQC believe in "quality." If I were to ask you, "Why is quality important?", you undoubtedly could give me many reasons, all valid and each one indicating your complete knowledge of the subject.

On the other hand, if you were to stop one man out of every five at the entrance to your plant and ask him the same question, what do you think the answers would be? The chances are that the responses would diverge widely from yours. Almost certain to emerge from your questioning would be the twin images of ignorance and misinformation.

The primary cause of employee lack of interest in the subject of quality is poor communication. Until this gulf between knowledge and ignorance is bridged, until you can successfully carry the message to the men who man the machines, your quality program will operate under a definite handicap. Conversely, if you can reach the minds of these employees, if you can plant the seeds of quality performance and nurture them with a continual flow of honest and factual inspiration, you will develop cooperation beyond your greatest expectations.

All this is not easy. Moving minds along a constructive path is rarely easy, but it is the *only* way to reach your objective of a total plant effort on quality.

Employee minds are not voids. Quite the contrary. They are active areas filled with an astounding variety of thoughts, most of which are personal in nature. When we realize the limitless

ASQC LCS Code 331:80:400

*Presented to the Third Annual All-Day Quality Control Forum of the Montreal section, ASQC, Montreal, Canada, October, 1959. Mr. Soule is customer relations director with Elliott Service Co., Mount Vernon, N. Y.

scope of potential thoughts and the limited capacity of any individual to concentrate on any single subject, it is quite apparent that creating or establishing quality consciousness calls for an organized and sound approach.

Reduced to a practical and action-taking level, creating quality consciousness means selling the need for and the advantages of quality to every employee. Basically, this job is identical to the process of selling any other commodity or service. Because the sales operation in the main is conducted within the confines of your plant, it can be properly called "In-plant selling."

Two important advantages of "In-plant selling" are immediately apparent:

First—every employee is a prospect

Second—your employee prospects are a captive audience every working day.

The approach to this vital selling operation calls for a well-directed, trained sales force equipped and inspired to sell quality. Its efforts, in turn, are supported and strengthened by aggressive advertising and promotion. In brief, then, the three basic phases of "In-plant selling" are:

Direction
Personal Selling
Advertising

Direction

Every sales effort, including selling quality, requires leadership. The organization of this leadership may vary by size of plant but it is fundamental that the quality control manager plays a major role in its operation. His intimate knowledge of the problem makes him an indispensable member. His enthusiasm is contagious.

A prime function of this directive effort is the defining of objectives. These must be reasonable and attainable. They should be reviewed periodically in the light of changing conditions and new developments.

Equal in importance to the establishment of progress targets is the indoctrination and training of your sales force. This brings us to the second phase of successfully selling quality.

Personal Selling

Selling quality and keeping it sold requires the strong appeal of personal contact. Again management is fortunate. It has at hand a ready-made sales force. These are your foremen and supervisors, the men who rub shoulders with your employees every day.

Operating in manageable and well-defined areas, the supervisor should be your personal emissary in the mission of selling quality. By practical experience—the trial and error discoveries of his day-to-day on-the-job contacts — he has a surprising knowledge of motivation. Even more important, he generally knows what particular appeals are most effective for specific employees. Link this knowledge to your quality objectives and you will have in the supervisor an invaluable salesman. Your area of influence is instantly extended throughout the entire plant.

Technically then, your organization for selling is already set up. But it has to be equipped and put into motion. You and your associates must impart to your supervisory staff all the fundamental benefits of quality and do so sufficiently well enough to inspire *in them* a desire to personally sell quality at the employee level.

No salesman can successfully sell a commodity he does not fully understand or sincerely believe in. No supervisor can convert employee thinking to the quality path when his own attitude is negative or lukewarm in that direction.

Creating quality consciousness in the employee at large begins with creating it *first* in the supervisor. Then, and only then, can he intelligently and effectively carry your message.

The importance of this step cannot be overemphasized.

Perhaps the best known and most effective means of raising supervisory efficiency and creating enthusiasm in these key men is through the training conference. Because it advances the free exchange of ideas and the dissemination of concentrated experience, it has particular value in developing a "team" approach. Such a unified effort, again, geared to your quality objectives, is critical to your cause.

Initial good intentions are dimmed in the course of time unless you apply fresh stimuli on a regular and frequent basis. Maintaining the supervisor's interest and enthusiasm is just as important as his thorough indoctrination. Included should be tangible and continuing evidence that you consider him an important part of management and a cornerstone in your plans.

Advertising

Closely associated with the supervisory selling effort is its supporting twin—advertising. This is a potent force and it can and should be used aggressively to advance quality consciousness in your plant. There is no question as to the effectiveness of advertising. It has become an integral part of our lives. We are surrounded with the tangible results directly traceable to this valuable communication medium. It is an excellent means of rapidly contacting many minds at one time.

In-plant advertising, in a very broad sense, embraces any and all means of carrying the message other than personal solicitation.

In-plant advertising includes such vehicles as:

Posters	Booklets
House Organs	Banners
Bulletin Boards	Physical Displays
Films	Envelope Stuffers

These are but a few of the many useful tools that management can utilize to reach the employee mind with the quality story. The greatest danger in use of advertising lies in using it too sparingly. Consider the value of your quality objectives, recognize the severe competition for employee thinking, and you will more fully appreciate the need for a maximum use of this productive medium.

Give your advertising a quality appearance. Let it reflect the same care and skill that it is endeavoring to create in the work-habits of your employees. Above all, let it be believable. The case for quality is so strong, so undeniably true, that it requires no fantastic embellishment.

Quality advertising provides you with instantaneous plant-wide exposure of the quality problem. This in itself is a major break-through. Employees can hardly get enthused over or devote much thought to a problem kept within administrative offices.

Every bit of quality advertising and promotion that you undertake

reaffirms the supervisor's faith in management's sincerity. Such advertising makes his personal job infinitely easier and more effective. Quality advertising preceding his sales effort prepares employee minds, makes them more receptive, more fertile for the seeds of quality acceptance he must sow.

As a consumer of goods it is inevitable that the employee is, on occasions, a victim of poor quality himself. He, too, has experienced the frustration and disappointment of product failure. Indeed he can be a most severe critic of the incompetent workmanship of others when it involves his own purchases and his own money. References in your selling and advertising that link his personal experiences as a purchaser to those of your company's customers have an unusually strong appeal.

In fact, the customer angle should be fully exploited throughout your entire quality selling effort. Too often the employee thinks only in terms of *his* job and *his* company. Help him to understand that without the customer there would be neither job nor company. Carry the case a step further and speak to him in terms of the *satisfied* customer. Show him complete dependence of business and industry on the people who buy.

Of particular significance in this "customer reaction" area is the need for keeping him reasonably informed on how people feel about your product. The display of customer letters, both good and bad, of sales made or lost, generally activates interest.

Advertising, including that designed to sell quality, needs initial impact and frequent change. It can never be allowed to grow static. Variety of approach is its very life blood because all people do not respond identically to any single appeal. There is no such thing as the "perfect" ad. Good advertising is the sum total of many approaches and many appeals, each one contributing in some measure to the end result.

There is, unfortunately, a deep seated belief in many employees that the quality control department is wholly and solely responsible for quality. They fail to see any connection between their individual jobs and the total quality picture. Both personal selling and advertising must ceaselessly work to erase this false impression and replace it with the truth—*everyone* is responsible for quality.

The key to effectiveness in creating employee quality consciousness both through supervisory selling and in-plant publicity is to make quality personal. Each time you relate your objectives to his or her personal welfare you are a step closer to securing free-will cooperation. Employees are rarely motivated simply because "it's good for the company." But if you can convince them that quality affects their jobs, their security, or their personal welfare, the acceptance you seek is in sight.

The program outlined here is by no means theoretical. It is working and successfully so in many plants. The formula on which it is based has stood the test of time.

However, there are also a few things to avoid in establishing a healthy quality consciousness program:

Don't run the program as a campaign and then drop it completely on the assumption that the job has been done. Invariably, when you stop selling quality, the employee immediately will assume it is no longer important. It is far better to run a consistent program than to explode into a skyrocket affair that fizzles into oblivion.

Don't shortcut the program because you think your company is different. Your products may range from locomotives to lipsticks but the steps to quality consciousness remain identical.

Don't let your production performance conflict with your quality consciousness program. Rush orders, get-it-out-the-back-door-in-any-fashion can make a mockery of your quality effort with employees. Let the keynote be CONSISTENCY.

Somewhere deep within every man and woman in your plant is a hidden chord responsive to the quality story. Just what particular appeal on which undetermined day will cause it to sympathetically vibrate, is something no one can foresee. But by your efforts, by your diligence, by your faith in this cause of quality it will happen. When it does happen to a sufficiently large number of employees, you will have successfully established quality consciousness and thereby vastly improved your company's competitive position in the economy.

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Some Comments on the Semantics Of Quality and Reliability

EUGENE L. GRANT and LAWRANCE F. BELL

Stanford University

"When I use a word," Humpty Dumpty said in a rather scornful tone, "it means just what I choose it to mean—neither more nor less."

"The question is," said Alice, "whether you *can* make words mean so many different things."

"The question is," said Humpty Dumpty, "which is to be master—that's all."

—Lewis Carroll in "Through the Looking Glass"

A Word is not a crystal, transparent and unchanged; it is the skin of a living thought, and may vary greatly in color and content according to the circumstances and the time in which it is used.

—Justice Holmes in Towne v. Eisner, 245 U.S. 418 at 425, 1918

WE HAVE BORROWED the two foregoing quotations from Chapter 1 of Professor J. C. Bonbright's book *Valuation of Property*,[1] in our opinion one of the outstanding books of this century. In part, Bonbright's book is great because he differentiates clearly the various different technical meanings of certain words, particularly *value* and *depreciation*. Much of the pre-Bonbright literature in the field (and, unfortunately, a fair amount of the post-Bonbright literature) suffers in soundness and clarity because writers unconsciously shift from one meaning to another.

When a word such as *value* or *quality*, which is widely and somewhat loosely used in everyday speech, is adopted into technical literature, it may develop a variety of technical meanings. Most of us are like Humpty-Dumpty in wanting our words to mean whatever we please. Nevertheless, there are obvious difficulties in communication when different persons adopt different technical meanings for the same word. These difficulties are increased when it is common for persons using a word to make unconscious and unidentified shifts from one technical meaning to another.

Some Technical Meanings Attached to the Word 'Quality'

The Shorter Oxford English Dictionary defines *quality* as "degree of excellence." This seems to be as good an approximation as any to the *popular* meaning of the word as it might be applied to manufactured product. In this sense, a person who states that one product has better quality than another presumably means that it has a more satisfactory degree of excellence. Obviously, the norm against which degree of excellence is judged may vary from one individual to another and often may not be defined clearly even in the mind of the person making such a statement. In most instances, quality in this popular sense cannot be expressed in terms of numbers.

In our observation of the common *technical* usages of the word quality with reference to manufactured product, there seem to

ASQC LCS Codes 352;830:70:000

be at least four different concepts associated with this word. We are not saying that a further subdivision of meanings attached to the word might not be useful; we are merely saying that this is the minimum number of quite different meanings that need recognition by persons engaged in industrial quality control.

A first meaning relates to the "degree of excellence" of the design objective. We shall refer to this concept as "quality of design." Various writers illustrating this meaning have used a comparison of the Cadillac automobile with the Chevrolet. However, it seems to us that there is considerably more to this concept of quality than this familiar example implies.

A second meaning relates to the effectiveness of the actual design specifications toward realizing the stated or implied design objectives. We shall refer to this concept as "quality of specifications."

A third meaning relates to the conformance of the manufactured product to the design specifications. We shall refer to this concept as "quality of conformance."

All of the foregoing three technical meanings of *quality* carry an implication of degree of excellence. However, there is a fourth meaning that is purely descriptive and carries no such implication. We shall refer to this concept as "quality in a neutral sense." For example, the resistance in ohms of an electrical circuit is a quality (or quality characteristic) of the circuit; the weight and tensile strength of a casting are qualities of the casting; the average service life of a group of electric light bulbs is a quality characteristic of the group.

The following simple example — a true story — will serve as a basis for comments on some relationships among these different meanings of quality.

An Example of a Designer's "Boo-boo"

A housewife purchased a high-priced electric range made by the X Company, a well-known large manufacturer. This range had two ovens. Normally, the housewife used only the smaller oven. However, after some months of ownership of the range, she needed to use the large oven to cook a turkey. The pan containing the turkey rested on a grating supported by projections on the two walls of the oven. The housewife was extremely unhappy when the grating, turkey, and pan fell to the floor of the oven because the inner wall of the oven was not stiff enough to support its side of the loaded grating.

When she complained to the retailer who sold her the oven, he explained that the X Company had discovered this weakness in this particular model of range and had provided a kit to be installed without charge. The retailer's service man installed this kit. However, several months later when she again attempted to cook a turkey, she discovered that the kit had not been effective; the turkey, pan, and grating again fell to the bottom of the oven.

This time the retailer explained that the guarantee period had expired and an alteration of the range could not be made without charge. However, he said that the company had now discovered the change that was needed to increase the stiffness of the inner wall of the large oven. When the service man came to make his estimate of the cost of this alteration (about $50), the housewife spoke quite unfavorably of the X Company. "Well," said the service man, "the X Company is usually pretty good, but it sure pulled a boo-boo when it designed the oven for this range!"

Some Points Illustrated by the Boo-boo Example

In applications to quality of conformance, the "degree of excellence" aspect is simple and straightforward. Any failure of a manufactured product to conform to a design specification is technically a defect. Any product containing a defect is defective. From the viewpoint of quality of conformance, defective product is unsatisfactory; product free from defects is satisfactory.

Nevertheless, even if all the ranges of the particular model discussed in the example had shown perfect quality of conformance to specifications, the ranges would not have satisfied their purchasers. The "boo-boo" made by the designer caused their quality in the popular sense to be unsatisfactory to the housewives who bought them. (Incidentally, the particular housewife in our example did not pay the $50 demanded by the retailer to correct the designer's error. In effect, she redesigned the support for the grating in the large oven by using four empty cans to hold it up at its four corners.)

Presumably the design objective, at least by implication, included sufficient stiffness in the oven wall to carry any loads that might normally be expected. The quality here was unsatisfactory in the second of the three technical meanings that we have listed; the design specifications were ineffective in realizing this design objective. The "quality of specifications" was poor.

Quality, in our first technical sense of the degree of excellence of the design objective, is almost always influenced by considerations involving manufacturing costs. Sometimes managerial pressure to keep costs as low as possible conflicts with managerial instructions about the degree of excellence of the design objective. We have no inside information about the source of the designer's error in providing insufficient stiffness for the oven wall. However, we do know that the X Company carries out cost reduction campaigns from time to time. A fair guess is that the designer reduced the thickness of the wall in response to the pressures caused by one of these campaigns; preceding models of the X Company's ranges had not contained this design error.

If so, this illustrates the well-known fact that the cost aspects of quality often are fairly complex. Doubtless, the adverse consequences to the X Company from the design change more than offset any saving in manufacturing costs. There must have been greatly increased service costs during the six months guarantee period due to the manufacture and installation of the repair kits. Moreover, it seems likely that there was a substantial loss of customer good will and a loss of confidence in the company's other products because of the unfavorable reactions of the buyers of this particular model of range.

Technical and Popular Meanings of Reliability and their Comparison with Meanings of Quality

It is evident that *reliability* has become a magic word in American industry during the past few years — particularly so in the defense industries. In this connection, a number of technical definitions of the word have been proposed. One definition from an official source is "the probability of no failure

throughout a prescribed operating period."[2] All the technical definitions that we have seen have one element in common; they seem to aim at a numerical measure of the "degree of excellence" of performance of a manufactured product over a period of time.

In trying to find the popular meaning of *reliability*, an obvious step is to look at the dictionaries. We have examined all the English language dictionaries we could find in several libraries. In none of the popular definitions of *reliability* that they contain is there any implication that this word has special reference to the period of time throughout which a product will give satisfactory service. The Shorter Oxford English Dictionary (which, incidentally, is in two large volumes) defines *reliability* as "the quality of being reliable." It defines *reliable* as "that which may be relied upon; in which reliance or confidence may be put; trustworthy." Webster's New International Dictionary gives no separate definition of *reliability*.

The lack of relationship between the popular and technical meaning of reliability is in sharp contrast to the close relationship between the popular meaning and the various technical meanings of *quality* as applicable to manufactured product. It will be recalled that the popular meaning is "degree of excellence." One technical meaning deals with the degree of excellence of the design objective; another with the degree of excellence with which the design specifications achieve the design objective; still another with the degree of excellence with which the actual manufactured product conforms to the design specifications. It is obvious that satisfactory quality in the popular sense is closely related to the existence of satisfactory quality in all of the three technical senses.

It also should be pointed out that satisfactory performance of a manufactured product over a period of time — the essential feature of the modern technical definitions of *reliability* — is merely one of the facets of *quality* in the popular sense. Moreover, all of the three technical senses of *quality* that relate to degree of excellence may involve, among other matters, satisfactory performance over a period of time. Using *quality* in its neutral sense, one of the quality characteristics often specified for manufactured product has been performance over a period of time; this type of specification existed long before the rise of *reliability* as a magic word in industry.

It seems to us that anyone who speaks of *quality* and *reliability* as if they were completely separate matters is merely being Humpty-Dumpty. More specifically, he is restricting the meaning of *quality* to exclude common aspects of its popular and technical meanings.

As somewhat detached observers of the quality control scene, we have therefore been puzzled by the recent view of quality and reliability as mutually exclusive matters. Whenever one of us meets a friend who is a member of a so-called reliability department or reliability group, we try in a more or less diplomatic way to find out what he does. Often, we ask him the leading question "Do you spend most of your time devising and interpreting life tests?"

The invariable answer to this question is "No." We usually are left with the impression that our questionee is, among other matters engaged in giving advice to designers. To employ the phrasing that we adopted in differentiating the various technical meanings of *quality*, our questionees are trying to improve the degree of excellence with which the design specifications lead to the design objectives. Or, stated more simply, they are trying to help in preventing "booboos" made by designers. The need for this kind of advice to designers seems to arise in considerable measure out of the newness and the complexity of the product being manufactured and the resultant need for the maximum feedback to designers of information from tests and field trials of the product.

It is noteworthy that these persons in reliability groups seem to have broken down the historical barriers in manufacturing organizations between designers and persons charged with responsibility for quality of conformance. Moreover, we do not get the impression that the advice that reliability personnel give to designers is limited to matters that affect the period of time throughout which a product will perform satisfactorily. It appears that many other aspects of the degree of excellence with which design specifications realize design objectives are also included in this advice.

The meanings of words, both popular and technical, develop and change with usage. It may be that because of the magic-word aspects of *reliability*, this word is starting to develop a popular meaning of degree of excellence of manufactured product over a period of time. (In fact, there seems to be an indication of this tendency in some recent television commercials.) If so, it will be desirable to recognize the same types of different technical aspects of reliability that exist in relation to other aspects of quality. Performance over a period of time is like any other quality characteristic in depending on the degree of excellence of the design objectives, on the degree of excellence with which the design specifications achieve the design objective, and on the degree of excellence with which the actual manufactured product conforms to the design specifications.

Historical Background of Barriers Between Designers and Persons Assigned Responsibility for Quality of Conformance

A rough generalization, subject to many exceptions, is that before the widespread adoption of modern quality control techniques and philosophy, designers tended to give little respect to any views on design expressed by members of inspection departments. Suggestions, if any, from inspection personnel to design personnel usually were intended to secure a liberalization of certain tolerances rather than to cause changes in aimed-at values of quality characteristics. Comments on the type of "booboo" made by the designer of the oven wall of the X Company's electric range were not viewed as the functions of inspection personnel.

Nevertheless, actions by inspection departments frequently had the effect of redesigning product through the failure to enforce specifications for certain quality characteristics. We have often heard inspectors defend such actions on the grounds that the actions did not hurt quality (in the popular sense of the degree of excellence of outgoing product) and that these actions were necessary to prevent excessive manufacturing costs.

Where sophisticated quality assurance groups existed, there also were barriers to communication between designers and quality assurance personnel. Back in 1949,

one of the authors of this article discovered that these barriers had the blessing of many of the quality assurance personnel. Some of his friends who had spent many years in administering quality assurance programs made comments to him on a paper that he had given at a meeting of the American Society for Testing Materials.[3] The title of this paper was "The Economic Relationship between Design and Acceptance Specifications." The concluding paragraph of the paper was as follows:

> The main purpose of this paper has been to suggest that there will be real opportunities for cost savings and for improved quality assurance in industry if decisions on design specifications are no longer made in disregard of the acceptance specifications that are to be used. Generally speaking, this means that those responsible for decisions on the design specification must get together with those responsible for selecting and administering the acceptance specifications. If they are to get together to good purpose, both groups must acquire the point of view of statistical methods.

A composite expression of the 1949 oral reactions of the author's friends to his ideas might be phrased somewhat as follows:

> What you have said is correct enough in principle. We agree that it is true that designers often specify tolerances that are tighter than really needed for the satisfactory functioning of a manufactured product and that—in effect—such tolerances are often relaxed by means of the procedures used in acceptance inspection. Nevertheless, it is completely unrealistic to propose that persons employed in quality assurance ought to make suggestions to designers regarding design specifications; any such action would be resented by designers. Moreover, if we should be invited to make suggestions about design specifications, consistency would require us to invite designers to cooperate with us in establishing acceptance specifications. But we have learned from bitter experience that it is not a good plan to have designers making decisions about acceptance specifications. On the one hand, some designers are inclined to insist—quite unrealistically—that *all* product conform exactly to *all* design specifications; AQL's and AOQL's would all be zero percent if some designers had their way. On the other hand, many designers are extremely unsophisticated on statistical matters and are inclined to place too much reliance on conclusions drawn from very small samples—in many cases from a sample of one.

We suspect that the 1961 climate on such matters is somewhat different from that in 1949. That is, designers are more sophisticated today than twelve years ago on matters related to process capabilities and interpretation of acceptance tests. For this reason, the objections on the part of quality assurance people to taking advice from designers are presumably less valid than they were twelve years ago. Moreover, the so-called reliability groups seem to have developed particularly in industries making new complex products. No doubt, designers in such industries are more willing to take outside advice than designers of other products. Possibly the fact that a number of the members of reliability groups have had successful design experience has helped to break down the natural reluctance of designers to take outside advice. Whatever the cause, it seems easier today to recognize that design objectives, the success of design specifications in achieving these objectives, and the means for judging whether product conforms to specifications, are three different facets of a single overall problem.

Some Lessons from Bonbright, Humpty-Dumpty, Alice, and Justice Holmes

The purpose of this article is not to suggest any particular organization structure for securing a satisfactory degree of excellence of manufactured product. The choice of a plan of organization in any particular case should depend, among other things, on the type of product being manufactured and on the capabilities and personalities of the persons involved.

Nevertheless, we have been distressed by observing the competition and jurisdictional disputes that sometimes have arisen between so-called reliability groups and so-called quality control or quality assurance groups. Disputes of this type seem likely to increase if the upcoming new "magic word" *maintainability* gives rise to the establishment of separate maintainability groups. There are, we believe, some points brought out by the quotations at the start of this article that may at least help in clarifying the issues involved in such disputes.

Bonbright mentions unfavorably "the traditional attempts to determine how property should be valued by reference to the silly question, What does value *really mean*?" Equally silly questions are what the words *quality* and *reliability* really mean. Decisions on organization structure and assumptions about the distribution of responsibilities within an organization should not be made with reference to such silly questions. Recognition should be given to the validity of Justice Holmes' statement that "a word . . . may vary greatly in color and content according to the circumstances and the time in which it is used."

Alice's remark to Humpty-Dumpty deserved a better answer when she said "The question is whether you *can* make words mean so many different things." Inevitably, words are used in a variety of meanings. The difficulties of communication arise chiefly when these meanings are close enough together that a shift from one meaning to another occurs without being recognized or identified.

Our plea in this article is that whatever word or words be used to represent various facets of the degree of excellence of manufactured product, there should be recognition that the same word is likely to be used at different times with different meanings. One meaning is the degree of excellence of the design objective; another is the degree of excellence with which the specifications realize that objective; still another is the degree of excellence with which the actual product conforms to the specifications.

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A NEW GRAPH For Determining C S P-1 Sampling Plans

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The three basic parameters of a Dodge CSP-1 plan are A = AOQL, f = sampling frequency and i = clearance number. Dodge's original graph [(1) p. 222, also (4) p. 20] gives f and i values for a selected set of AOQL values. This is satisfactory for determining a plan whose AOQL's belong to this set, but interpolation for other AOQL's is extremely difficult.

Another set of CSP-1 plans is given in H-107[5]. These plans are indexed by a set of AOQL values corresponding to the AQL values in MIL-STD 105, and by frequencies f = 1/n = ½, ⅓, ¼, ⅕, ⅐, 1/10, 1/15, 1/25, 1/50, 1/100, 1/200. Interpolation for AOQL values not listed in this table is again extremely difficult.

For many applications of CSP-1 plans the required frequency may be found in the set used in H-107, and a new graph has been computed using these f values. This graph covers AOQL values from 0.1 to 10 percent and i values up to 1000, and should suffice in almost all situations where CSP-1 plans are required.

Dodge[2] has also provided a graph covering i values less than 10. Rather than extending the graph in this article to cover these i values, the exact AOQL values for the f values of interest are given in Table I.

As an alternate to using the graph a set of f, i, A values may be determined quite accurately from the values given in Table II using logarithmic interpolation.

Example 1

Given f = 1/5 and i = 30 to find A.

$$\log 20 = 1.3010 \qquad \log 3.44 = 0.5366$$

$$\log 30 = 1.4771 \qquad \log A = ?$$

$$\log 40 = 1.6021 \qquad \log 1.76 = 0.2455$$

therefore, by interpolation

$$\frac{1.4771 - 1.3010}{1.6021 - 1.3010} = \frac{\log A - 0.5366}{0.2455 - 0.5366}$$

$$\log A = 0.3663$$

and hence

$$A = 2.324\%$$

The exact value of A is 2.326 percent.

ASQC LCS Code 224:70:400

Example 2

For f = 1/5, find the clearance number i corresponding to A = 2 percent

$$\log 20 = 1.3010 \qquad \log 3.44 = 0.5366$$

$$\log i = ? \qquad \log 2.00 = 0.3010$$

$$\log 40 = 1.6021 \qquad \log 1.76 = 0.2455$$

$$\frac{\log i - 1.3010}{1.6021 - 1.3010} = \frac{0.3010 - 0.5366}{0.2455 - 0.5366}$$

and

$$\log i = 1.5447$$

$$i = 35.04$$

The exact AOQL for i = 35 is 2.002 percent

Generally speaking, interpolation is more accurate for large i values (100 ≤ i) than small (10 ≤ i ≤ 100); however, since i is actually a discrete variable, logarithmic interpolation should be sufficient for problems similar to Example 2 for all values of i. To be on the conservative side the i value should always be rounded upwards; e.g., i = 35.02 would

TABLE I—CSP-1 Exact AOQL's (in percents for i ≤ 10)

f \ i	2	3	4	5	6	7	8	9	10
1/2	10.59	7.67	6.01	4.94	4.20	3.65	3.22	2.89	2.62
1/3		12.41	9.78	8.08	6.88	5.99	5.30	4.76	4.32
1/4				10.40	8.87	7.73	6.86	6.16	5.59
					10.46	9.13	8.10	7.28	6.61
							10.03	9.03	8.20
								10.94	9.95

TABLE II—CSP-1 Exact AOQL's (in percents)

f \ i	10	20	40	70	100	200	400	700	1000
1/2	2.62	1.35	0.685	0.394	0.277	0.139	0.070		
1/3	4.32	2.23	1.14	0.655	0.460	0.231	0.116	0.066	
1/4	5.59	2.90	1.48	0.852	0.599	0.301	0.151	0.086	
1/5	6.61	3.44	1.76	1.01	0.712	0.357	0.179	0.102	0.072
1/7	8.20	4.29	2.19	1.27	0.890	0.447	0.224	0.128	0.090
1/10	9.95	5.23	2.68	1.55	1.09	0.548	0.275	0.157	0.110
1/15	12.01	6.34	3.26	1.89	1.33	0.668	0.335	0.192	0.134
1/25	14.68	7.81	4.03	2.34	1.65	0.828	0.415	0.238	0.166
1/50	18.38	9.88	5.13	2.98	2.10	1.06	0.531	0.304	0.213
1/100		12.03	6.28	3.66	2.58	1.30	0.654	0.375	0.262
1/200		14.23	7.48	4.37	3.08	1.56	0.783	0.448	0.314

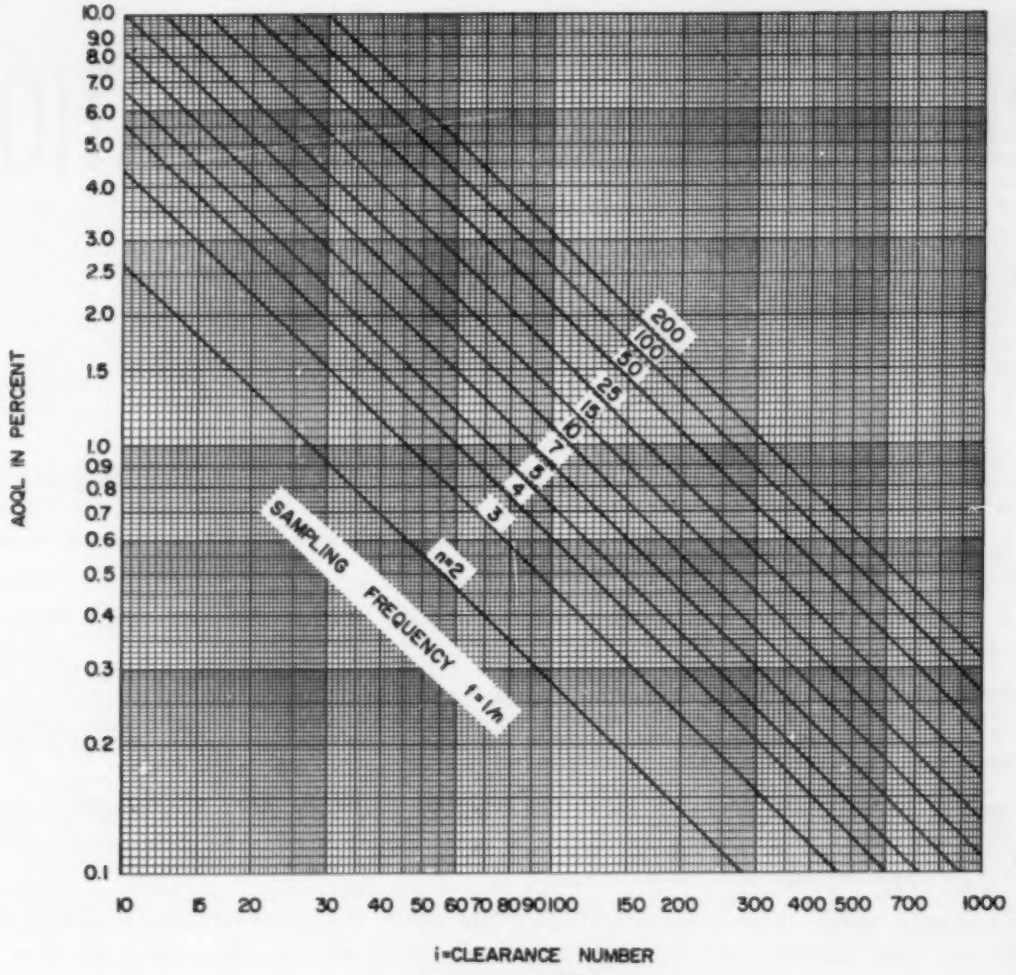

Figure 1—Dodge CSP-1

be rounded to i = 36. This insures that the AOQL of the chosen plan is not larger than the specified value. For Example 2, this rounding technique gives the plan f = 1/5, i = 36, A = 1.947 percent rather than f = 1/5, i = 35, A = 2.002 percent.

Since, for fixed f, the curves are approximately linear with slope —1 (with respect to the log-log paper) we also note that, for fixed f, plans with AOQL's A_1 and A_2 and clearance numbers i_1 and i_2 satisfy the approximate equations

$$\log A_1 \approx -\log i_1 + \text{constant}$$

$$\log A_2 \approx -\log i_2 + \text{constant}$$

$$\text{or } A_2/A_1 \approx i_1/i_2$$

This approximation was first noted by Dodge and Torrey[3].

In Example 1 above, for f = 1/5, let $i_1 = 20$, $i_2 = 30$, and $A_1 = 3.44$ then $A_2 = A \approx 20\ (3.44)/30 = 2.293$ percent

$$A_2 = A \approx 20\ (3.44)/30 = 2.293 \text{ percent}$$

On the other hand, interpolation from above with $i_1' = 40$, $A_1' = 1.76$ gives

$$A_2 = A \approx 40\ (1.76)/30 = 2.347$$

For Example 2 this technique yields

$$i_2 = A_1\ i_1/A_2 = 3.44(20)/2.00 = 34.4, \text{ or}$$

$$i_2 = A_1'\ i_1'/A_2 = 1.76(40)/2.00 = 35.2.$$

As might be expected, since 35 is closed to 40 than 20, the second result is more accurate.

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PRIMER ON EXPERIMENTATION

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Doing What Is Appropriate

THE CREATIVE INDIVIDUAL has been defined as "a man working at the utmost intensity of which he is capable toward an end to which he is wholly committed."[1] The key to success is the individual's capability. Experimentation is a manifestation of the creative part of technical or scientific work.

Since experiments don't (or shouldn't) just happen, skill in designing them must be a part of the successful experimenter's knowledge.

Many of the blocks that have been encountered in the past to profitable solution of problems may have been due to failure to appreciate and put into practice the principles of experiment design.

To get to the practical level of every-day research and development or engineering, perhaps an attempt should be made to define in operational terms the problems which an experimenter has to face.

For example, it has been suggested[2] that the mark of a true professional is the ability, in whatever situation he finds himself, to do something appropriate to the occasion. Our concern, then, should be to find out what to do that is appropriate to the occasion of designing an experiment.

Two aspects of experiment design which should be given particular attention are the use of background data and the thorough understanding of the model upon which the experiment is constructed. The quality of the background data is very important whether they are already available or are to be collected, especially, in a preliminary experiment. Further, the underlying physical system must be thoroughly understood so that the correct statistical model may be selected to represent it.

It is appropriate, whenever planning an experiment, to consider the degree to which the available background data and the measurement procedure by which new data are to be produced possess the characteristics of validity and pertinence. Validity has to do with precision and accuracy; pertinence has to do with whether a test has measured the property that it is supposed to have measured. It will be well to dwell on these characteristics at some length.

ASQC LCS Codes 521;522:60;70:400

A person already acquainted with the principles and language of experimental statistics will find the contents of this article to be quite elementary. However, it is not written for laymen unfamiliar with terms such as mean square, degrees of freedom, regression, or interaction. There are many quality control engineers and research and development scientists acquainted with these terms although they do not have particularly strong statistical backgrounds. It is intended that the presentation inspire those interested in learning more about experiment design to study the basic principles.

Precision and Accuracy of Testing Methods

Precision of a test method is, quite generally[3,4] taken to mean the extent to which independent, repeated measurements of a quantity cluster about their average. It is an inherent property of the method which is changed only when the test method itself is changed. It is not changed simply by increasing the number of measurements used to determine it. An increase in the number of measurements only improves our estimate of what the precision is.

It is observed, however, that the term "precision" is used also in the sense of the confidence limits of an average of measurements. In this usage, increased sample size does enable us to increase the precision of statistical estimates. In dealing with a test method, it should be looked upon as a process which must be defined. The precision calculated may be applied only to the measurement process as it has been defined.

Precision is conceived of as being a measure of the random, or non-systematic variation in the measurement process. Any constant or systematic variation, or bias, is considered to be related to another

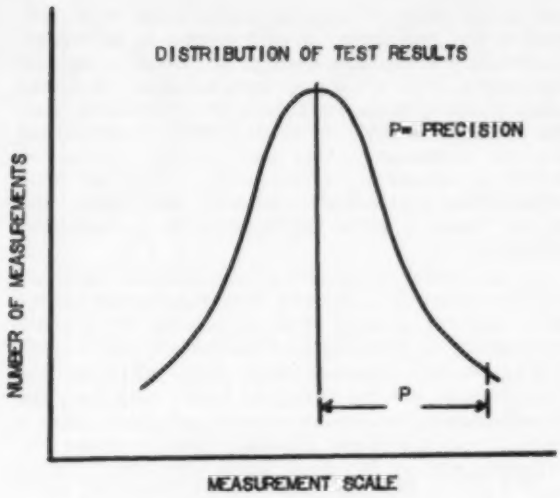

Figure 1—Precision

property of the method, its accuracy. The measurement of a systematic variation requires an accepted reference or standard value outside of the measurement process. Accuracy consists of the bias (difference between the reference value and the average of a series of measurements) plus precision. These concepts of precision and accuracy are represented in Figs. 1 and 2.

The most generally accepted expression for the spread of measurements is their standard deviation. Since, the greater the clustering, the smaller the standard deviation, precision is inversely related to the size of the standard deviation. Thus, if Method A has a standard deviation less than that of Method B, Method A may be said to have greater precision than Method B.

Since precision is a property of all the possible independent measurements of a quantity, it must be estimated on the basis of a sample of measurements. The cost of testing is an important factor in selection of sample size. However, consideration should be given also to making the variance of our estimate of precision small. The question may well be asked, what does experience indicate to be a very small and a very large sample? It is suggested that for the purposes of determining precision, 25 or less is a very small sample and 100 or more, a very large one.

Although the standard deviation is a measure of precision, it is practical to define precision in terms of an interval which may be expected to include a given percentage of all measurements made by the method. If a satisfactory estimate of the standard deviation has been obtained, distribution theory provides the multiplier required to get the interval which will include the desired percentage of measurements. If, as is generally true for measurement of variables, normal distribution theory can be applied, a multiplier of three will include "practically all" measurements and has proved to be satisfactory in use.

When it is desired to specify a standard for precision, it is necessary only to specify a value which shall not be exceeded. Thus, one may specify that precision shall be within 0.2 lb., meaning that the interval calculated as suggested, shall not exceed 0.2 lb. This will apply, of course, only to a particular measurement process that has been defined.

There are many levels of precision that are generally recognized, such as, within-experiment, between-operators, between-test equipments, within-laboratory, and between-laboratories precision. It is well known that there are conditions surrounding any test, both recognized and unrecognized, that may change with time. Also, it is known that instruments of the same make vary from one another and that different operators' results will vary.

However, it is not unreasonable to assume that instrumental differences may be kept very small by proper calibration and that operator differences may be minimized by careful standardization of procedures and by training. A well-managed laboratory will check routinely on these two aspects of the method, so that the use of more than one instrument or of more than one operator will not decrease precision significantly. Routine surveillance also provides an opportunity for correcting any unusual change in variability caused by the things that change with time.

The possibility arises, therefore, of limiting to two the levels of precision which we will be commonly called upon to use: 1) within-laboratory precision and 2) between-laboratories precision.

Within-laboratory precision applies to a measurement process consisting of a single instrument-operator combination in a single laboratory. This process must be "controlled" in a statistical sense, that is, all variation must be random, or, all "assignable causes" of variation must have been identified and removed.

For between-laboratory precision, the process is redefined to include different laboratories. The differences between laboratories are assumed to be random differences. Methods may be devised for checking routinely on this randomness. If this random variability is of sufficient extent to make the combined within-laboratory and between-laboratories variability significantly greater than within-laboratory variability alone, then it may be desirable to assign intervals to both the within-laboratory and between-laboratories precision.

In expressing accuracy, it is desirable to indicate whether the bias over-estimates or under-estimates the reference value. Thus, one might report that the accuracy of a method is 0.5 lb.; 0.3 lb. bias over-

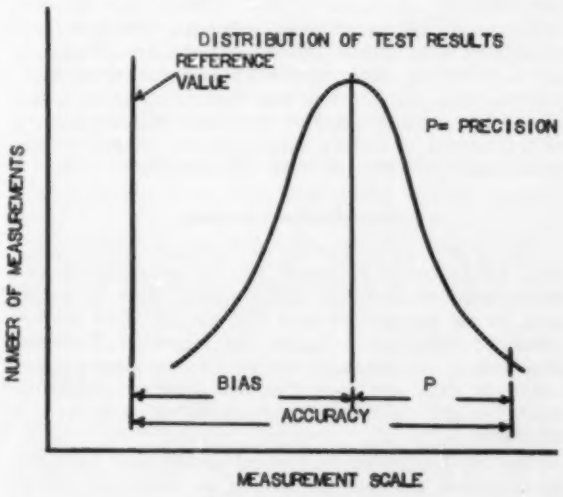

Figure 2—Accuracy

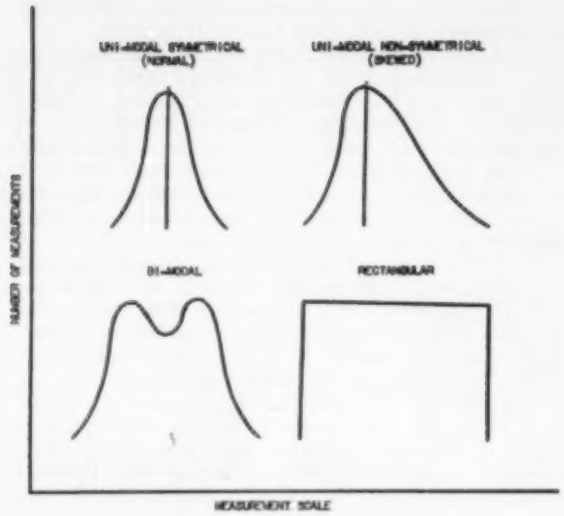

Figure 3—Typical Frequency Distributions

estimate plus 0.2 lb. precision. When reporting either precision or accuracy, one should define the measurement process involved and state either the multiplier of the standard deviation or the probability level used. It is also of note that some experimenters prefer to use the coefficient of variation (that is, the standard deviation as a percentage of the average) as a measure of relative precision.

Pertinence of Testing Methods

Having gone into the definition of precision and accuracy in some detail, consideration will now be given briefly to another characteristic of a test method, its pertinence.

There are two aspects of this characteristic of a test: 1) the relationship between measurements and some performance characteristic of the item being tested; and 2) the relationship between measurements and what we think we are measuring.

Correlation and regression techniques may be used to measure the first relationship.

Our keenest engineering and scientific talent will be needed to answer questions about the second relationship.

We may not be able to solve all the problems associated with either aspect. But we should always try to verify by experimentation and statistical analysis that the test method has real meaning in terms of end use requirements of the item. The importance of this aspect of testing should not be judged by the small space allotted to it in this article.

Examination of Data

Often, little or no background information is available before an experiment has to be designed and performed. Sometimes, much useful data is available or an amount of data can be obtained readily which is sufficient to guide the selection of sample size and of an efficient pattern for a new experiment. If data are available, an attempt should be made to get as much information as possible out of them.

One of the useful first steps which may be taken by research workers in looking at numerical information is to set it out as a distribution curve and look at its shape. It may be worth while to do this even if the data seem, at first glance, to be trivial. Particularly if the data seem to be trivial, it may be desirable to take this simple step, because it is sometimes possible to secure sufficient information from the distribution curve to make subsequent statistical analysis unnecessary. One may classify distribution curves as uni-modal symmetrical, uni-modal non-symmetrical (or skewed), bi-modal, rectangular, and so on. Figure 3 gives representations of these distributions.

A uni-modal symmetrical distribution indicates uniform practice. A skewed distribution may represent uniform practice with occasional irregularity or possibly the presence of a log-normal distribution.

Swan[5] has observed that when machines (or instruments) are the principal factor in a test, the distribution of results is normal, but that when a human response is the principal factor, another distribution applies. Psycho-physicists have now proved that a power function describes the operating characteristics of a sensory system[7]. Another slant is that the genesis of the skewed distribution may be similar to that of the normal distribution, small errors being multiplicative instead of additive. In any event, investigation of the reasons for skewness is indicated.

A bi-modal distribution indicates that there are two sets of conditions and that it will be worthwhile to find out what these are.

The appearance of a rectangular distribution may be horrifying, and perhaps it should be. It may mean the presence of a highly special set of circumstances but it most likely means the presence of a large number of small distributions, or in other words, chaos. Many times a rectangular distribution for a particular process can be traced back to chaotic conditions in the stages previous to the one being studied.

Another way of taking a quick look at data (applying the "eye-ball test") is to plot scatter diagrams of the inter-relationship of two variables, as illustrated in Figs. 4 and 5.

This step should discourage work in areas where the relationships are very poor and raise the warning sign to prevent treatment of data that is non-linear using the assumption of linearity.

It is sometimes helpful to plot the data as control charts, particularly since many analytical techniques assume homogeneity of the data and the test for

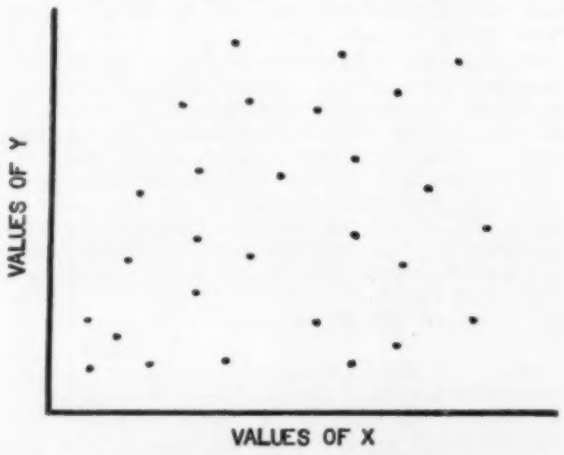

Figure 4—Scatter Diagram (1) Plot of Poorly Related Variables X and Y

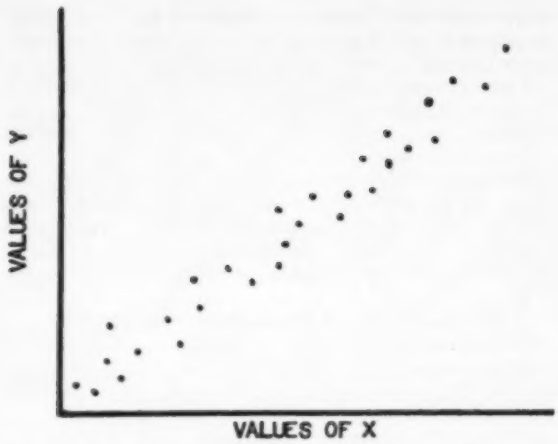

Figure 5—Scatter Diagram (2) Plot of Closely Related Variables X and Y

control is essentially a test for homogeneity. Also, it is common to screen the data for outliers or unusually dispersed values and statistical techniques are useful in this effort.

With examination of data sources completed, we are ready to go ahead with details of an experimental plan. The background data will be useful for calculating how much experimentation needs to be done. They will be helpful in arriving at decisions regarding the sizes of the differences it is desired to detect and the risks that are to be taken. They provide, therefore, the basis for the statement of the problem to be solved. However, even if there are no background data, there are many advantages in beginning with a statistical design. There are major gains to be made even if the planning of the design starts from scratch.

Silly Questions Get Silly Answers

It is verifiable through our daily experiences that silly questions get silly answers. Thus, to avoid silly answers from our experiments, we need to ask smart questions. This is exactly what is behind the insistence of the experiment designer on a clear statement of the hypotheses in advance. This requires a good understanding of the nature of the physical phenomena involved in the experiment. As a result, suggestions are made such as the one that the statistician should be familiar with the content of the experimenter's notebook.

A valid conclusion requires that the questions be asked before looking at the results of an experiment. This is not to say that many important scientific discoveries have not been made without having well-defined questions in advance. But when fortuitous results do occur, it is always necessary to set up new experiments to verify what we have observed. These new experiments are designed to ask well-defined questions about the new phenomena.

Another rule of the game is that the hypothesis shall be a "null" hypothesis, that is, we hypothesize that prescribed changes in conditions will have no effect. The results will then test, at the selected risk level, whether the changes had no effect. If the statistical test indicates a large change compared to the one expected by chance alone, we conclude that the hypotheses that there has been no effect is disproved. If the test indicates no larger change than accounted for by chance, we do not say that the hypothesis is proved, but only that the hypothesis has not been disproved. We cannot say that there is no real effect, only that the evidence is insufficient to convince us that it is so.

The Model of the Experiment

The careful phrasing of the questions to be asked makes it possible to construct a systematic representation of the experimental arrangement to be used.

Consider the tabulations in Tables IA and IIA. The first of these, Table IA, is a representation of a situation in which any single measurement of some property of a product is made up of variable parts which,

Table IA—Basic Model 1

Temperature (T)
Rate of Thruput (R)
Interaction (T × R)
Experimental Error (E)

in addition to the average property of the product, consist of the effect of variable T, plus the effect of variable R, plus the effect of the interaction of T and R, plus the effect of experimental error. T and R are independent experimental variables which, it is assumed, may interact. There is some simplification possible if the latter assumption is unwarranted but the difference is minor and the implications need not be further considered here. A model of this sort, in which the variables are independent but interacting, is called a "crossed model." The mathematical expression of this is :

$$X_{ijn} = \mu + T_i + R_j + TR_{(ij)} + E_n$$

The second model, Table IIA, represents the situation in which any single measurement of some property of a product is made up of variable parts which,

Table IIA—Basic Model 2

Containers	(C)
Samples	(S)
Tests	(T)

in addition to the average property of the product, are the effect of a variable C, plus the effect of a subdivision of C, the variable D, plus the effect of a subdivision of variable D, to obtain experimental error. A model of this sort, in which the variables are each dependent upon the ones that have gone before is called a "nested model." The mathematical expression is:

$$X_{ijn} = \mu + C_i + S_{j(i)} + E_{n(ij)}$$

Mixed models of all degrees are possible.

An example of the first type might involve varying factor T, temperature of a process, through two or more levels and factor R, rate of processing of material, through two or more levels and repeating at least once the various combinations of T and R. This is illustrated in Table IB.

An example of the second type might involve sampling several containers, C; taking two or more

Table IB—A Crossed Model

	Temperature 1 (T_1)		Temperature 2 (T_2)	
Throughput 1 (R_1)	Run	Run	Run	Run
Throughput 2 (R_2)	Run	Run	Run	Run

Order of runs to be randomized

Table IIB—A Nested Model

Container 1 (C_1)				Container 2 (C_2)			
Sample 1 (S_1)		Sample 2 (S_2)		Sample 1		Sample 2	
Test	Test	Test	Test	Test	Test	Test	Test

Order of tests to be randomized

samples, D, from each container; and performing two or more tests on each sample. This is illustrated in Table IIB.

Note the use of the term "factors" to describe the variables in the experiment and the term "levels" to describe the selection of steps throughout the range at which the factors are to be applied.

Factors may be fixed or random. If fixed, the levels are specified or determined in advance by the nature of the variable or they may categorized in a non-random way. For example, there may be only two settings, high and low, on a control device; on the other hand, we may be able to select levels of a factor, such as temperature, anywhere we wish along a continuous scale.

If the factor is random, the items to be tested at each level are selected in such a way that all available items have an equal chance of being selected each time a selection is made. For example, if two samples of a batch of material are desired, the samples are selected by chance in such a way that any and all portions of the batch had an equal opportunity of being selected; or if a sample of five out of a dozen similar instruments or production machines are to be tested, the five are selected from the dozen by use of random numbers or in some other completely unsystematic way.

For random sampling, a refinement is necessary if the selection is made from a finite source but since we usually have or can assume that we have an infinite source from which to sample, we will consider only the general case.

Referring again to the two models, we may summarize and amplify a bit. The variables considered, called "factors" in the experiment, are designated by capital letters. The parts that are added to make up any single measurement of a property of a product are called the "effects" of the experiment, such as average effect, effect of T, effect of R, effect of $T \times R$ interaction, and effect of experimental error. The number of levels is also of interest and, in blocking out the experiment, the levels are usually indicated by subscript numerals. For example, T_1 and T_2 may represent a low and a high level of T, respectively.

Except for the average effect, all the effects are variable effects which may be estimated in terms of mean square deviations from the average. To illustrate this, a tabulation is given, showing the important information from an experiment. A two-factor crossed model with replication, with both factors random, might involve temperature readings using different thermometers and operators, both chosen at random. The mean squares assignable to each effect may be broken down into sources as in the right hand column in Table III.

The mean square deviation assignable to interaction ($T \times O$) is made up of parts due to the interaction and to the error; that assignable to operators is made up of parts due to the operators, the interaction, and the error; and that assignable to thermometers is made up of parts due to the thermometers, the interaction and the error. In an actual experiment, the degrees of freedom for each effect are known and it is possible to calculate the component of variance due to each effect.

This tabular method or some more direct method of analyzing the experiment is necessary for understanding how to go about comparing the various effects. Reference (6) is a good source of techniques.

These estimated mean squares are important because we are now able to tell what significance tests may be made to determine the level of significance of each of the effects. Starting at the bottom of Table III, with the experimental error mean square, we

Table III—Two Crossed Random Factors with Replication

Effects of Factors	Degrees of Freedom	Mean Squares Sources
Thermometers (T)	Amount of Information	$E + TO + T$
Operators (O)		$E + TO + O$
$T \times O$		$E + TO$
Error (E)		E

consecutively test the effects by dividing each by the next lower significant effect which contains all of the effects except the one of interest. Thus, interaction effect is tested by error; T and O effects are tested consecutively by the interaction effect, if it has been shown to be significant at the selected level of risk, otherwise, they are tested by the error effect.

We may now proceed to the second kind of model and thence to any simple or mixed models that we may desire to examine. Among those that it will be interesting to look at will be one in which some of the effects have become inseparable, or confounded, and for which there may be no formal test of significance possible. It is situations of the latter type that we wish to avoid unless we have consciously planned how the confounding shall be permitted.

For our next example we can use the experiment with containers, samples, and tests, a three-factor nested model, all factors random, with mean squares sources broken down as shown in Table IV. For nested classifications, the significance tests always are made between successive rows and the one immediately below, if it is significant, with no skipping of rows.

The effect on the example of Table III of including one fixed factor, where O is a fixed factor, for example, two selected operators—Jerry and Tom, is shown in Table V. The effects of interaction and factor T are tested by the error term, but factor O is tested by the interaction. The rules for testing fixed factors are of a different nature than those for random factors.

Next, let us consider an experiment in which main effects and interactions are confused or confounded. This can be the experiment with random selection of thermometers and of operators with random selection of constant temperature baths added as a third factor, shown in Table VI. Note that there is no rigorous test for the main effects, which have been confounded with the first order interactions. The right hand column of the table shows that none of the effects by which the main factors effects might be tested contain all but one of the effects which the main factors contain.

Table IV—Three Nested Random Factors

Effects of Factors	Degrees of Freedom	Mean Squares Sources
Containers (C)	Amount of Information	$T + S + C$
Samples (S)		$T + S$
Tests (T)		T

The Importance of Replication

There is no true error term in this last experiment, nor in any experiment where there has been no replication of runs. However, the second and higher order interactions are frequently used as error terms. This is a mistake, of course, if they happen to have large mean squares. Sometimes the experimenter is lucky and interaction effects are very small. If, in the last table, at least two of the first order interactions were insignificant when tested by the second order interaction, the difficulty that there is no rigorous test of significance would be eliminated. At least one of the interaction terms would disappear from the main effect mean squares and all would be testable either by the remaining significant interaction or by the (pseudo) error term. However, even in this circumstance, if the second order interactions were very large, it could mask true significance of the main factors. The only trustworthy way of assuring that significant factors, if present, are detected is to provide a true measure of experimental error and to see to it that sampling, testing, and the chance errors of experiment are kept as small as possible. Experimental error is minimized by strict control of test to make it most precise, by understanding sampling variability so that its effects may be made small, and by watching that all the variables supposed to be held constant (or controlled) are in fact controlled to an adequate degree. The effect of experimental error is also minimized by increasing the size of the experiment, either by performing more replications, or by arranging the plan of test to maximize the capabilities for combining data to compare averages of as many tests as possible.

It should be noted that in speaking of replication of experimental conditions, exactly what is meant is the repetition of the work in all or a significant fraction of the total combinations of the factors run. It does not mean simply running second samples under the same arrangement of factors and most certainly it does not mean simply running duplicate tests.

The Role of Randomization

The apparent differences among the effects of experimental factors may be due to poor control of factors not of concern to the experimenter or due to unknown factors which may introduce biases by the way they act. To guard against the inflation of certain effects at the expense of others, care must always be taken to randomize the experiment in such a way that there is equal chance of the extraneous factors affecting any part of the experiment. For randomization to be effective, the experiment must be large enough so that random occurrences of strong effects will more or less balance out in the various parts of the experiment. The way randomization is carried out will depend on what is known about the way in which the uncontrolled or uncontrollable variables may affect results. Thus, if there is likely to be a difference between work done in the morning and afternoon, some of each part of the experiment should be done in the morning and some in the afternoon and there must be enough such opportunities for chance choice of morning or afternoon runs so that the balance over the whole experiment is reasonable.

Table V—One Fixed and One Random Crossed Factors with Replication

Effects of Factors	Degrees of Freedom	Mean Squares Sources
Thermometers (T)	Amount of Information	$E + T$
Operators (O)		$E + TO + O$
T × O		$E + TO$
Error (E)		E

Table VI—Three Crossed Random Factors Without Replication

Effects of Factors	Degrees of Freedom	Mean Squares Sources
Thermometers (T)	Amount of Information	$TOB + TO + TB + T$
Operators (O)		$TOB + TO + OB + O$
Baths (B)		$TOB + TB + OB + B$
T × O		$TOB + TO$
T × B		$TOB + TB$
O × B		$TOB + OB$
T × O × B		TOB

If the unwanted factors are known to act in specific ways, a systematic balancing of the experiment so that each part is equally affected is an alternative way of sharpening the contrasts. For example, if two machines are to be used in an experiment, it might be desirable to have the total number of runs divided equally between them so that differences between the machines would be equally balanced out when comparisons were made of effects of the factors being investigated.

The opportunities for randomization and balance will become apparent when occasion arises for design of real experiments. Almost always, time of carrying out phases of the experiment should be randomized to take care of the almost certain changes in conditions surrounding the experiment simply due to the passage of time. We can also readily think of conditions, such as meteorological events which are beyond our control, which suggest the need for balancing.

Conclusion

The principal purposes of experiment design are:

1. To test the significance of experimental variables (screening for the most important variables in our problem)
2. To determine the size of effects of changing experimental variables (estimating average responses to changes made)
3. To separate variation into its components(ordering the size of variations incurred)
4. To describe the relationships among the experimental variables (expressing results in form of equations or graphical plots)

Whatever the purpose of the experiment, you can lay a safe bet that your experimental score will be improved if you never fail to take advantage of the suggestions that have been made.

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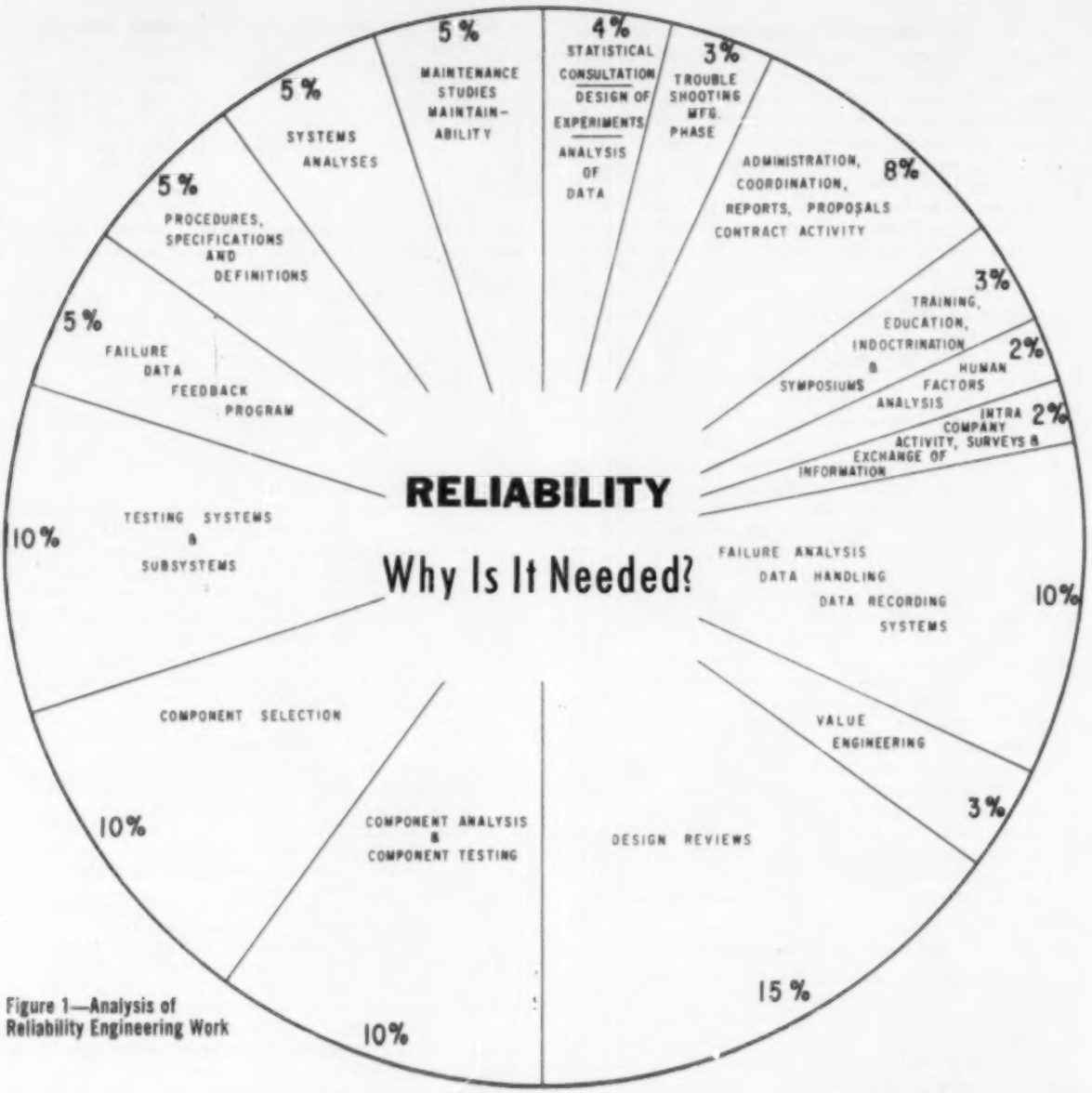

Figure 1—Analysis of Reliability Engineering Work

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MANY COMPANIES and branches of companies do not have the services of a Reliability Engineering specialist. Every company's organization does not necessarily require a specialist on its staff, but this article is presented for those companies contemplating the use of a reliability specialist.

The basic problems in establishing a reliability function are that the people responsible do not always know WHERE to begin, WHEN to start, WHO is required, HOW to best use and WHY a reliability effort is needed.

WHY, HOW, WHO, WHEN and WHERE the reliability effort fits into the industrial picture requires lengthy discussion and can become very complex. This article will attempt to describe why reliability is needed. It is generally conceded that reliability is defined as: "Reliability is the probability of performing without failure a specified function under given conditions for a specified period of time."*

Therefore, the purpose of a reliability engineering effort is to integrate the various specialties of the sciences in order to obtain maximum failure-free operation (useful life) from the products produced and sold under the conditions of use established by negotiation with customers.

This integration function can be further explained as an interpretation or translation of results of tests or the principles of one specialty into a usable form in another specialty area.

The Reliability Engineer can be evaluated as to his ability to

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*AGREE Reports, "Reliability of Military Electronic Equipment," June 4, 1957, Task Group 3, p. 118

gather information and/or data, interpret its meaning and explain the meaning to other specialists. This enables other specialists to work with the added information which is now available to improve their designs. Therefore, "Reliability Engineering" is the integration, interpretation, coordination and the motivation needed to increase the useful life of economically produced products. The complexity of the answers to our queries becomes obvious as we examine WHY the reliability effort is needed.

Why a reliability effort is needed usually is answered by an employee trying to convince his superiors that they should either hire or assign a person to the task of Reliability Engineering. It seldom happens that someone just starts working in this field without some sort of directive or approval from a superior.

Basic Reasons for Reliability Engineering

In order to justify the need to have someone given this responsibility the following basic reasons are submitted:

Customer Requirement

The most important reason today is that our customers are requiring more failure-free operation and longer life from the products we produce. The government is specifying hours, days, weeks, months or years of failure-free operation for military apparatus. This parameter is measurable and we can be adjudged in non-compliance if we deliver a product that does not meet all characteristics of the specification. The military services have by specification forced some companies to expend additional effort to meet the requirements. For example, the services are developing equipment to be parachute-dropped into enemy territory or placed there by some other means, which will transmit to our receiving stations the locations of all transmitting facilities and all military ordnance facilities. These equipments will necessarily be small, compact, and rugged, *and* will have to operate for a period of time without maintenance. Other remote stations are being used in the Arctic, Antarctic, Texas Towers and in buoys, which also are going to be in a position of operating without maintenance for long periods of time, some as much as a year. These are in addition to the classic unmanned satellites and missiles. With the shortage of military personnel made mandatory by reduction in funding of the military services, even conventional equipment has to be more adequately built so as to reduce the military manpower requirements and increase the *up* time of the equipment.

Customer Need

Our other customers—non-government and non-military users of electronic equipment—also require long life, failure-free operation and economical use of the products they purchase. The airline customer desires electronic controls, weather radar and communication gear. Taxicab and trucking companies, police and fire departments require radar, communication and safety electronic equipment which are mobile, portable and rugged. Banks, accounting offices, municipal governments, schools, and other businesses require computational equipment, data processing and automatic accounting machines. Industry requires electronic equipment in automated production facilities. Each commercial user wants zero non-productive time and low maintenance costs for the equipment purchased.

An example of the customer requirement in a non-military area was illustrated in *Electronic News* dated Nov. 23, 1959: "Dissatisfied Philadelphia Won't Pay for System." In short, the article stated that the city of Philadelphia purchased a $600,000 mobile police radio communication system. It listed the following causes of dissatisfaction as the basis for nonpayment:

1. "Base stations, receivers, transmitters inadequate and undependable in performance." This is basically a performance and reliability characteristic. This could have been specified and a test agreed upon at which time the manufacturer could have tested the equipment prior to acceptance. In this case, specifications and tests were not specified.

2. "Mobile units, receivers, and transmitters are also inadequate and not dependable." Same comment as above.

3. "Full duplex operation not satisfactorily provided." Duplexing is usually a term that is used in sales brochures but not often satisfactorily defined.

4. "Frequency stability lacking in all units." "Microwave equipment not up to specification." These specifications are not free of controversial terminology.

This example indicates that we, as manufacturers, must comply with the intent as well as the letter of the specification or purchase document. Of course, customers seldom resort to the press to list their complaints but in some cases such as this the customer becomes so dissatisfied that he tries to use public censure to bring manufacturers around to meeting our moral obligations. However, the city of Philadelphia is not free of criticism. One of the problems was that it never specified the functional parameters adequately. In other words, Philadelphia may be skating on thin ice in claiming non-compliance. Although this example involves electronics, other industries are also plagued with these problems.

Competition

Competitors have reliability specialists and, therefore, to keep up with them we had better join the bandwagon. This is a weak, but often-heard, reason that has more of the flavor of an excuse. It is listed so that we are aware of it. Even so, the military services are evaluating the ability of manufacturers to meet reliability and quality requirements, among others, prior to sending out requests for quotes. The manufacturer who has the facilities and technical ability already in being will be most favored. The Government will choose those organizations that are willing and capable of complying with the general standards without having specific project specifications imposed. We are seeing this more and more every day.

Design Complaints

Customers expect to see someone in the supplier's organizations specifically charged with the responsibility of hearing their complaints other than the Sales Department. They want to see someone representing them before the product is delivered. This is not the classical quality control job of inspection and quality assurance in manufacturing, but the job of aiding designers to design better equipment by using information gathered on other jobs and the use of new techniques in design and manufacture.

The delicate subject of Reliability or Quality Control has been

broached and it is believed that design personnel and manufacturing personnel are different types of individuals; manufacturing types are generally extroverts and the design types are introverts. The designer is concerned with design detail and the other is concerned with logistics, time study and the like. Gaining confidence of manufacturing personnel usually takes a man who is conversant in manufacturing methods, policies, procedures and the intricacies of dealing with material handlers, stock clerks, wirers, inspectors, shippers and receivers, packaging personnel, truckers and other non-technical, usually hourly paid employees. It is a rare person indeed who can mix and work happily with production personnel at 9 a.m. and at 10 a.m. convince the designer that a technical detail has been overlooked in a design. There are very few of these "types" available even though they are needed desperately.

The person needed in the engineering area to improve the inherent reliability of the equipment manufactured is not the man who concerns himself with the number of threads extending beyond a nut, or whether or not a solder joint is cold, or whether or not the finish on the cabinet is of the proper shade, texture and thickness, or whether the name plate is on in the proper location with the proper nomenclature.

The design engineer designing the equipment needs to be convinced, in my opinion, that the reliability engineer is a capable individual who can contribute to the design of the product by direct contribution to the paper design effort before the model is built. Placing this responsibility in one department called Product Assurance may work theoretically, but in practice—because of the personalities involved—the planning and development stages of a project will have to be handled by a personality and capability different from that of the manufacturing and production individual.

Therefore, the method of operation that is suitable for the personalities involved in general will require the services of a Quality Control Engineer to deal with manufacturing personnel and the Reliability Engineer to concern himself with the theoretical study programs and design and development stages of a project. Occasionally, it is found that the customer wants to be able to talk to someone in the Design Department during the study, design and development stages; and in the manufacturing phase, someone in the Production Department. Complaints can then be directed by the customer directly to the group involved. The term "product assurance" is a generic term that may be applied to the entire manufacturing process.

Statistical Engineering

The need by designers of complex equipment to have statistical assistance in designing electronic tests, evaluating data derived from tests and analyzing mountains of historical information available on other equipments is required. This assistance is needed to reduce the time needed to conduct the tests, to minimize costs of testing, to get the most out of the data while considering interaction effects of characteristics as well as the effects of the variable nature of the characteristic itself.

Unless the designer designs his test program around some valid statistical concept, he will find himself spending anywhere from five to ten times the amount of money in his test program that he needs to spend to find the answer.

The data derived from individual tests performed by an engineer hunting for information is usually not as good and usually cannot be evaluated satisfactorily. In one particular case it was estimated that $400,000 could be easily spent in a test program by the cut and try method. With the aid of the Statistical Engineer the cost of performing the tests amounted to $60,000. The data were more accurate and more easily evaluated and thus there was greater assurance that the results were correct.

One of the major tools that our organization uses is the statistical design test procedure, which the Test Department requests of the engineer. This procedure requires that the design engineer answer a series of questions, which will indicate whether or not the designer is going to perform additional tests on the same product or on similar products. Lately the Test Department has reached the point where it is asking the designer, "Have you seen the reliability engineer or the statistical department for the design on this test?" These procedures are reducing our testing costs quite considerably. Statistical techniques such as Analysis of Variance* are of the type utilized.

General vs. Specialized Knowledge

Design problems have been found to be lacking solution since many problems are involved with many more specialties than the usual design engineer has at his command. Design problems involving reliability usually require the integrated thoughts of mechanical and electrical engineering personnel, as well as metallurgists and physicists. It has been found that in order to integrate these specialties, a person with a general engineering background is required. General engineering is not a good term to use for reliability personnel, but it is a term that is best described by the fact that a reliability engineer has been exposed to many of these types of problems in almost all of the specialty areas. The reliability engineer has experience in design and manufacturing activities, which have involved investigations requiring knowledge in the other physical sciences. The reliability engineer must be conversant with the terminology and techniques used in solving problems within these other specialty areas.

Management has, in many instances, recognized the value of the reliability engineer in integrating the specialties mentioned above.

Human Problems

The reliability engineer has been involved with other technical problems, which have evolved from the man-machine concepts of the psychologist. He has, therefore, become conversant if not expert in problems relating to the operators, the maintenance men, manufacturing assembly techniques, as well as the human failing that we all have in making errors, improper evaluations and misunderstanding someone else's specialty.

Since reliability pertains to successful operation of an equipment in the customer's hands, the area of interest of the reliability engineer has expanded to include the problems of maintenance, maintenance engineering and the ability

*Hicks, Charles R., "Analysis of Variance," *Industrial Quality Control*, Vol. XIII, Nos. 2, 3, 4, August, September, October, 1960

of an equipment to be adequately maintained in the field. This would include problems in the area of spare parts, identification nomenclature of parts, circuits, components, assemblies, etc.

Shipping problems have also been included in the portfolio of problems the reliability engineer has had to solve in order to provide high levels of availability of the equipment in the customer's hands.

Most human factor problems are combinations of engineering and psychological factors. It so happens that most companies are using psychologists and in some cases sociologists without prior engineering exposure. Some of the results that have been observed are more concerned with the human being's comfort, the color of the walls, the lights, the rapidity of flashing lights, the distance of reach to pull a switch or lever, the readability of labels, and the artistic touch. Don't misunderstand, these are important, but what hasn't been touched upon is the ability of the human to repair and take apart apparatus and to understand the instruction books. Additional work is now necessary to improve the repairability or the maintainability of the equipment.

Cost and Value Evaluation

Value analysis and cost considerations have required the reliability engineer to become involved with cost vs. operational functional parameters. When cost reduction personnel recommend a process change thus reducing the cost of manufacture, reliability engineers are required to evaluate the proposed changes and the effect on the reliability of the equipment. The reliability engineer must participate in value analysis so as to reduce complexity and increase mean-time-between-failures and reduce maintenance time.

The article, "The Compatability of Value Engineering Analysis and Reliability" published in *Industrial Quality Control*, May, 1959, presented a series of case histories on how the Reliability Engineer and the Value Analyst improved reliability and reduced costs.

Coordination and Integration for Reliability

The need to coordinate such efforts as systems analysis, maintenance, statistics, test, value analysis, etc. is ever increasing and the designer usually doesn't have the time to be interested in determining the quantitative degree of assurance that all components of the equipment behave in the specified manner. It is also usually not the designer's basic interest to concern himself with all of the various and sundry problems brought about by considering cost, delivery, maintainability, human factor problems, spare parts, nomenclature and other design problems. Yet this portion of the design job must be done and the reliability engineer aids the designer by performing the coordination function.

Results of Meeting the Need For Reliability Engineering

Many of the factors making up the reason why industry needs reliability engineering functions have been discussed above. The results of meeting this need has changed procurement methods, manufacturing techniques and acceptance procedures for both military and commercial equipment.

Among these changes we find that the purchasing agent buys fewer catalogue items, for which the purchase order lists only the catalogue number, the quantity and the date to be delivered. We currently find the purchase order listing the applicable specifications, either the military or commercial.

Test procedures are being detailed with test data, environmental parameters, even the test equipment and the type and level of the personnel required to perform the test.

The purchase order is no longer a single sheet of paper. It now runs from 10 to 25 pages, listing all sorts of detail; the higher the reliability requirements, the more detail is required.

Manufacturing facilities are also affected by the current need for greater reliability. These needs are not new, only the quantitative measurement of the need is becoming more pressing.

Manufacturing personnel and quality control engineers have been familiar with the reliability problem for many moons, but quality control personnel have not been required to give more than lip service to life requirements.

Now that these requirements are made specific and in most cases measurable, we need more than lip service. Manufacturing facilities must be cleaner, neater, better planned, laid out, controlled and much more equipment is needed in the manufacturing cycle.

There are less people being placed on an assembly line today, but much more equipment. The people are being used in the production and maintenance of the equipment, which produces portions of the apparatus that yesterday the individual produced.

Manufacturing facilities must have life test equipment and personnel with experience.

Records are more stringent, clerical operations more important. Even the mailmen bringing data from other sources are part of the reliability team.

Acceptance procedures and acceptance methods must now take into consideration not just AQL's, but also Average Reliability Levels (ARL's). The time in receiving inspection is no longer the 24 hours desired by the manufacturing department, but some greater number since life tests, qualification tests and many other specification tests, measurements, and evaluations must be made. We also find that acceptance procedures today include the acceptance of equipment—not only of piece parts.

Equipment procedures are more lengthy and include many more requirements than we have required in the past from our subcontractors. In most cases, even for the simplest of units, we impose upon our sub-contractor the inconvenience of having a resident or itinerant representative.

Some of the jobs that the reliability engineer or specialist does are depicted on the chart shown in Fig. 1.

In this chart we have attempted to reduce to words and percentage of time the work of a group of Reliability Specialists over a period of time. We determined the percentage of time on each task by evaluating the total time spent on various tasks by the group of reliability specialists.

This breakdown indicates to us that Reliability is a many pronged task; in order to perform these tasks, specially trained or experienced personnel are required.

Designers are specialists required to devote their time in developing new frontiers. In performing the tasks outlined in Fig. 1, the reliability specialist aids him in these efforts.

Statistical Quality Control Applications In the Food Industry

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IN RECENT YEARS, there has been a tremendous advance in the use of quality control techniques based on mathematical applications of the laws of probability. It has become quite apparent that 100 percent inspection and testing of a production line is seldom feasible, particularly when the test is destructive.

Systems for estimating and controlling the quality level from measurements of small samples have been developed and it is possible to estimate the degree of precision of these estimates from the data. Similar sampling techniques for estimating the quality of given lots of manufactured items or raw materials with known degrees of risk have also been developed. The use of these various techniques is what we know today as "statistical quality control." The interest in their applications is evidenced by the ever increasing membership in the American Society for Quality Control, now numbering in the neighborhood of 13,000.

"Heralded as one of the great new developments of industrial technique," says Dr. Kramer,[12] "Statistical quality control has been thought by many to be primarily related to such uniform product endeavors as making tools, machines, and the like.

"Thus, application of SQC in biological fields, such as food production, has been presumed less feasible, particularly because here difficulties abound due to inherently greater variability of the raw materials.

"But this is a restricted viewpoint. Actually, much of the early work in SQC was done in the food field—precisely because natural variability of the materials was so great, and factors effecting quality of product so many, that better means were required to distinguish cause and effect and thus speed the

ASQC LCS Code 720:00:420

way to remedial measures through changes in material, equipment, or production procedures."

Kornetsky[15] suggests, "Variability that exists in food materials has been a deterrent in the application of statistical quality control charts to food manufacturing processes. While it is recognized that food products are more variable than the manufactured articles of other industries, this in itself does not exclude the use of control charts; it merely indicates that control (limits) must be wide and must be adjusted to the situation."

In 1955, Dr. Hosking[8] reported the results of a survey of the use of SQC in the food industries. That report indicated that 64 percent of all food industries were using SQC. Dr. Stier[27] makes the statement, "As food processing has become more and more a continuous process and less of a batch process, the use of statistical control techniques has increased."

THE purpose of this article is to describe very briefly some of these applications. No attempt has been made to detail the methods used nor is the list complete. Many of the references do describe individual techniques in detail and can be used by the processor as applicable.

That the food industry recognizes the importance of statistical procedures is evidenced by the fact that the National Canners Association Laboratory Manual[34] has a very complete chapter on statistical procedures. This book describes variability, probability, control chart methods, sampling, correlation, some basic taste panel techniques and other procedures commonly used.

There are other training manuals such as those published by the University of Iowa[35] and the St. Louis[36] sections of ASQC, as well as a number of good books on statistical methods and their application to quality control. One of the important values of the aforementioned manuals lies in the fact that they are easily understood by those with little or no basic statistical background. One need not understand the complicated mathematical derivations to use and understand the methods themselves. The lack of realization of this fact has been a deterrent to the applications of SQC in many cases. It cannot be overstressed.

AS these SQC procedures have come to the attention of food processors, they have looked about for possible points of application. One of the most prominent is that of fill of container which seems to be a straightforward and rewarding application. Much has been done and written on SQS applied to fill of container in the food industry. In 1954, the National Canners Association Convention included a symposium on fill[22]. Some basic methods of fill control using $\bar{X}$ and R charts were explained and the advantages and improvements were demonstrated. The advantage of reducing the variation and thereby reducing the average fill *without increasing the number of under-fills* was demonstrated.

Twigg[30] gives a method for checking on the uniformity of individual filler pockets. He demonstrates by example that malfunctioning of a filler can cause non-uniform filling among the pockets which, if corrected, would save an estimated two and one-half percent of the fill-in weight, this by reducing the average without increasing under-fills. He describes a method of constructing $\bar{X}$ and R charts and mentions some advantages of this type of control system, such as:

1. Catching a gradual change in fill level which might otherwise go unnoticed
2. Preventing unnecessary and often harmful adjustments and changes
3. Locating assignable causes of variation

Bremer[2] emphasizes the practical aspects of control chart work on a packaging line. He suggests that, for some operations, control limits based on two standard deviations rather than the conventional three standard deviations may be beneficial. Limits set up for individual packages rather than averages are often useful because the results more nearly approximate field practices of regulatory agencies. The use of a second set of control limits twice as wide as the regular control limits was attempted, but it was found that the operators were biased and tended to try to stay within the first and second lines on the high side, which nullifies much of the improvement of the control method. The performing of the weight checks in consistent communication with the operators made them realize the importance of the control of net weights. It is also pointed out that, in some cases, fillers or filling units produce such good weight patterns that the fill-check operation became monotonous because the weights were all either "0" or plus or minus 1. This was corrected by changing to a scale of increased sensitivity which produced less monotony and improved the operator's attention. It is emphasized that the function of Quality Control is a *service* and definitely *not a police or punitive* function.

REYNOLDS[23] "offers a simple yet effective method of establishing a practical, workable weight control system over most types of filling operations." He makes the very practical suggestion that whole numbers should be used rather than fractions. For instance, $\frac{2}{32}$ over the scale zero should be recorded as +2. He suggests that increments of weighing should be small enough to show changes, but no smaller than necessary. For instance, if the normal expected range of weights varies over $\pm\frac{1}{4}$ lb., probably increments of $\frac{1}{8}$ or $\frac{1}{16}$ oz. are acceptable. If, on the other hand, the total spread of weights amounts to $\pm\frac{1}{16}$ oz., probably increments of $\frac{1}{64}$ oz. would be needed. Both group and random distribution methods of capability testing of the machines are given. The group plan consists of drawing samples of five consecutive packages from the line and weighing as is done in normal $\bar{X}$ and R chart construction. The random distribution plan consists of drawing one sample at a time and obtaining a single sample distribution. It is pointed out that the group plan should normally be used because it is not affected by changes in the over-all fill level. A method for establishing the average fill desired, based on a designed percentage of underweights, is given. This is simply done by setting the average fill as far above the minimum fill as necessary to yield the desired percent of underweights as determined from the table of cumulative probabilities of the normal distribution curve. It is cautioned that in actual practice, the percent underweights will apparently be somewhat less than the desired because of a peculiarity of recording, wherein, if the scale is being read to $\frac{1}{8}$ oz., any weights which fall between $\frac{1}{16}$ above and $\frac{1}{16}$ below the minimum or "O" are counted

as exact weights. Actually, a part of them would be shown to be below if the units of measurement were smaller.

ANOTHER source[31] presents a table of standard deviations of the fill of different food products. This demonstrates the direct relation between the ease of filling and the standard deviations obtained. In most cases, heterogeneous products have higher standard deviations of fill than the more or less homogeneous products; i.e., whole beets versus juices.

Harrison[7] explains the relation between individual package weight and case weight. It is shown that there will be very few (or no) cases underweight even though a small percentage of the individual packages are underweight, if the underweight packages are randomly distributed. On the other hand, if the underweight packages are clumped, as is normally the case, the percentage of cases which are underweight will approach that of the individual packages. It is suggested that some method of randomizing packages from a filling line be investigated so as to minimize the percentage of cases which are underweight.

Donohue[3] describes some of the problems involved in controlling a filling line which has several spouts or several machines and gives a solution involving a "variance analysis technique." This involves checking each individual machine and/or each spout for abnormal adjustment or variation. Analysis of the various interactions indicated, among other things, inherent variation in the stock fed to the machines. This work resulted in readjustment of some machines, redesign of the packaging line, the setting up of operating control limits and a system of individual machine checks and "realized a state of control that approaches the inherent variability of the machines."

Gieseker[6] uses a lot plot sampling procedure adapted to line control (fill, in this case). This is not as tight a control as $\bar{X}$ and R chart control. It is "practical when many of the assignable causes for variation—are known from past experience."

Rowe[25] and McBride[21] have both shown that normal variation is recognized by the regulatory agencies. Regulations generally state in effect that the fill of a product must average a specified weight but with "reasonable variations consistent with good filling practices."

WEISS[33] describes how the Food and Drug Administration sets up standards based on what it believes to be good manufacturing practices. He also points out that "the use of a lower limit of acceptability constitutes a tolerance." "Assuming that the variability in the product is not controllable, if production were changed so that the average weight were to be shifted from the recommended fill to that just above the lower limit of acceptability, the end result would be that a substantial proportion of the product would be substandard. The limits are set so that by conforming to the recommended fill, the ensuing product will be considered acceptable. This is not a tolerance." He also describes a multiple sampling plan or modified sequential plan for checking on the conformance to standards. Thus, products of good character or very inferior character are acted upon quickly while those of border line character require more samples for final action.

The American Marketing Service (USDA) has developed multiple sampling plans for inspecting fruits and vegetables[1]. These tend to reduce sample sizes (from the former sampling plan) and, thus, the cost of inspection.

Kornetsky[16] suggests the use of control charts for determining the effects of the sorting and trimming operations in sweet corn. Samples of the raw product are drawn and checked for defects and plotted on a control chart. Presumably, if they are out of control on the high side, the number of inspectors would have to be increased or the rate of processing slowed down in order to effectively inspect and trim the corn. Similarly, samples are taken after trimming and inspection and the defect infestation measured. If out of control, it would show a need for improving the inspection and trimming section. The use of a control chart for controlling the consistency of cream style corn is also demonstrated.

KRAMER[14] demonstrates the relation of sample size to error in the sampling of raw green beans as well as suggesting a sampling schedule based on the MIL-STD-105A. He shows the effect of sampling error on the percent seed, shear press and percent fiber determinations on the sample. In-plant control of the snipping and filling operations are briefly described and a control chart demonstrating finished product control is suggested. In another article[11] he points out several types of sampling procedures for food products.

Kramer and Steinmetz[13] obtained a correlation coefficient of 0.86 between the shear-press values of raw beans and the percent fiber of canned beans. From Table I, shear-press versus percent fiber, a system for raw produce grading is proposed, whereby beans below a given shear-press reading are generally acceptable and those above a given shear-press reading would probably produce a sub-standard canned product, the area between the two levels being questionable. Since green beans increase in size with maturity, this method lends itself to in-plant control of green bean processing based on the raw product shear-press values. For instance, with low shear-press values, one might can the 1-2-3-4 sieves separately or in various combinations as whole beans, and cut the large sieves. But, if the raw shear-press were high, one might discard the larger sieves without canning because there would be very little chance of their being better than sub-standard. (The relation of shear-press to fiber should be determined separately for each variety of beans.)

Table I—Shear-Press Versus Percent Fiber

SHEAR-PRESS	PERCENT FIBER	
1200	0.01	
1250	0.03	
1300	0.05	
1350	0.07	
1400	0.09	
1450	0.11	Questionable
1500	0.13	Area
1550	0.15	
1600	0.18	
1650	0.22	
1700	0.27	
1750	0.35	
1800	0.46	
1850	0.65	
1900	1.00	

Statistical techniques have been employed to experiments involving the testing of cans which have considerably reduced the cost of these experiments. Normally, cans of varying structural designs are

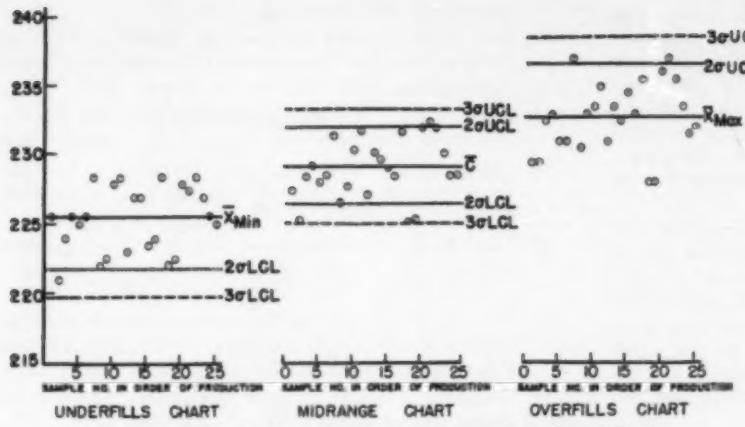

Figure 1—Some Sample Data Plotted as Extreme Value Control Charts

filled, processed and cooled in water highly contaminated with gas-forming bacteria. Cans which leak will almost certainly swell in a short time.

In at least one test of this nature, the difference in number of swells among the various types of can structures was insignificant because the number of cans tested was too small. Statistical calculations have greatly reduced the risk of this type of needless expense (since the test had to be re-run) by showing the number of cans which needed to be tested in order to determine any significant difference in the number of spoiled cans among the variables. Table II is the result of one such calculation:

Table II—Calculation to Determine the Number of Cans Which Needed to be Tested in Order to Determine Any Significant Difference in the Number of Spoiled Cans Among the Variables

Assume control cans to have spoilage in cans per thousand	If it is necessary to determine differences between groups of ( ) cans per thousand	This number of cans should be tested
5.0	1	40,000
4.0	1	33,000
3.0	1	25,000
2.0	1	17,000
1.0	1	10,000
5.0	2	12,000
4.0	2	10,000
3.0	2	7,000
2.0	2	4,500

Tarver, *et al*,[28] describes a statistical method for selecting flavor panel members to be used for detecting small flavor differences in paired samples. They have very carefully pointed out that this type of panel is a tool for the research and development laboratory and cannot be considered as a consumer acceptance panel.

Tarver and Schenck[29] describe a method of using *extreme value* control charts to control the actual maximums and minimums rather than averages or ranges. Charts in Fig. 1 show some sample data plotted as extreme value control charts. The chart on the left is obtained by plotting the lowest sample value from each subgroup. Likewise that on the right is obtained by plotting the highest value from each sub-group. The average of the maximum and minimum values are plotted on the midrange chart. The major objective of these extreme value control charts is the specification of tolerances for over-fills and under-fills under normal operating conditions. Thus, in this example, any fill below 220 grams is an underfill and any fill over 238 grams is an over-fill.

Weimerskirch[32] reports a method of top seam control of the can closing operation and an acceptance sampling plan for incoming cans. One of the results of this work was an increase in the control limits beyond the machine capabilities which had the advantage of reducing the amount of actual controlling. Such action, however, is not always feasible and should be taken only after careful consideration. The acceptance sampling plan was sequential in nature but truncated after a certain number of samples had been examined, if no previous decision had been reached. Different operating characteristic curves are used for each of two classes of defects. Considerably larger AQL and LTPD values are used for the less serious defects as is to be expected.

Lang[17] reports on the use of an acceptance sampling plan based on MIL-STD-105A for glass jars. In this case, three classes of defects with appropriate AQL values are used.

Filice[5] describes some control chart applications to the fill of fruit, pH control, total solids of tomato products, and labeling lines. He demonstrates a very rewarding result of raw product research on pears. A system for determining maturity of a lot of freshly harvested pears was developed and from this, by continual sampling of these lots, a system for predicting the number of storage days necessary to ripen to optimum maturity for canning. In addition, lots of excess variation can be segregated and handled differently in the canning process.

McPhail[20] describes the use of quality control charts in controlling the acidity of vinegar with a resultant saving.

Ritchell[24] describes the problems involved in a packaging line such as torn labels, dog-eared labels, dented cans, dirty cans, unsealed or poorly sealed cases, poor stenciling, etc., and the control system used to reduce the number of packaging defects. In this case, a "number defective" chart is used. A sample is drawn periodically after labeling, casing, and sealing and the defectives noted and plotted. Control limits were calculated from the first data taken in this manner and have dropped considerably since the inception of this packaging control program. It was found necessary to set up different limits for different types of labels, since foil labels are more difficult to handle than paper labels.

A number of cases describing problems and their solution through statistical quality control techniques were presented at a National Canners Association problem session in April, 1956. Many of these have previously been mentioned at least by type; however, there are one or two which show a different approach to these problems and warrant mentioning.

A difficulty was encountered in obtaining uniform fill of dry limas and pork and beans. In this case, a modification of the "lot plot" sampling procedure was used, first to determine the current operating conditions and, then, as a control procedure. It was felt that this could be used instead of

$\overline{X}$ and R charts, "because of the intimate knowledge of the supervisory personnel with the problems of filling these products." It was found that, in some cases, filler speeds could be materially increased without altering the uniformity of fill. Also, fillers could be evaluated and the data and charts were used to confirm the need for new fillers. This particular type of data also yielded an estimate of the spillage on the filling lines.

SQC was applied by one canner to the sizing and canning of small whole onions. The problem lay in not getting the smaller onions out (the smaller onions are more valuable). After some equipment changes were made, $\overline{X}$ and R charts were used with some success. One interesting comment in the early stages of the data taking read as follows: "Our inspector fell and broke her arm—no charts for two weeks."

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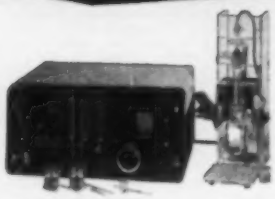

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(as of February 28, 1961)

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FLANARY, BILL J., Bristol, Tenn.
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GRIFFITTS, JAMES H., Butler, Tenn.
HAYS, NORMAN W., Johnson City, Tenn.
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SIMS, L. GORDON, Johnson City, Tenn.
SLAGLE, ERNEST P., Elizabethton, Tenn.
STEED, HOWARD S., Johnson City, Tenn.
STOVER, DAVID E., Johnson City, Tenn.
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AMERICAN SOCIETY FOR QUALITY CONTROL

Hotel Sheraton, Philadelphia, Pa.

SPECIAL EVENTS

JUNE 5, 6, 7

SUNDAY, JUNE 4,

8:00 P. M. Early Birds Reception

MONDAY, JUNE 5,

9:00 A. M. Welcome, Annual Meeting, Saddoris Award

9:00 P. M. Social Evening: A Night in Olde Philadelphia

TUESDAY, JUNE 6,

9:00 A. M. Executive Session:
H. Thomas Hallowell, Jr.,
President, Standard Pressed Steel
"Quality Control, Reliability and Waste"

6:30 P. M. Annual Banquet: Guest Speaker,
James N. Davis, Deputy Assistant Secretary of Defense for Production Management
"Reliability–Where Do We Go From Here?"

WEDNESDAY, JUNE 7,

9:00 A. M. Honors Convocation:
Address of the Shewhart Medalist

Quality Control in the Quaker City

Executive Session Speaker

H. Thomas Hallowell, Jr., president of Standard Pressed Steel Co., will present "Quality Control, Reliability and Waste," during the Executive Session 9-10 a.m., Tuesday, June 6.

Regardless of your level in the quality control organization of your company, you won't want to miss the business management viewpoint from an executive of a well known international producer of precision metal fasteners; aircraft, missile, nuclear and electronic components, as well as office furniture and steel shop equipment, with plants in six countries and employing more than 7000.

Mr. Hallowell

Mr. Hallowell is executive, economist, inventor and world traveler. He is a director of the Philadelphia National Bank, Abington Memorial Hospital, and many industrial companies.

He is past president and director of the American Standards Association, a director of the Pennsylvania Manufacturers' Association, director and regional vice president of the National Association of Manufacturers, and president of the Manufacturers' Association of Montgomery County.

Mr. Hallowell was graduated from Swarthmore College in 1929 with a degree in economics. He serves on the board of managers of Swarthmore College and is a Trustee of the Pennsylvania State University.

Annual Banquet Speaker

James N. Davis, who was recently appointed Deputy Assistant Secretary of Defense for Production Management, will discuss "Reliability—Where Do We Go from Here?" during the Annual Banquet at 6 p.m., Tuesday, June 6.

Mr. Davis fills a newly created position in the Defense Department in which he is responsible for product lead-time and decision-making.

Experience in government and industry will aid him in fulfilling this new role. For three years, from November 1951 to November 1954, he was Special Assistant for Research and Development to the Under Secretary of the Army.

In 1954, Mr. Davis was named consultant to the Operations Research Office of Johns Hopkins, and was assigned to make a study of NATO war plans and weapons for the Assistant Secretary of Defense (International Security Affairs). In 1956, he served as technical director for an executive Defense Department weapons group, and the following year was a consultant to the Committee on Aviation Facilities Planning.

Mr. Davis

Since February 1960, Mr. Davis has been vice president of the Bell Aerosystems Co., Buffalo, N.Y., where he served as manager of the aerospace and rocket operations, and from 1957 to 1960 was vice president for Government operations for Vertol Aircraft Corp., Morton, Pa.

Mr. Davis was born in Shelbyville, Ind., on Nov. 7, 1912. He was graduated from Purdue University in 1936 with a B.S. degree and received his Masters degree in 1938, and was awarded an honorary degree in 1959.

LADIES' PROGRAM

For the ladies who will be attending the convention with their husbands the following excellent program has been lined up by the committee.

MONDAY, JUNE 5

10:00 A. M. Coffee Hour—Informal talk by Bonnie Small, Western Electric Co., Allentown, Pa. on the subject: "Quality Control and Your Husband."

1:30 P. M. Walking Tour—Historical Philadelphia.

TUESDAY, JUNE 6

10:00 A. M. Coffee Hour.

12:00 Noon Luncheon and Fashion Show by the Lillian Albus Shop.

1:30 P. M. Walking Tour—Philadelphia's leading shops and stores.

WEDNESDAY, JUNE 7

10:00 A. M. Coffee Hour and Walking Tour—Antique shops along Antique Row.

15TH ANNUAL CONVENTION PROGRAM

MONDAY, JUNE 5

Session	Period 2 — 10:15-11:45 A. M.	Period 3 — 1:30-2:30 P. M.
A	**MANAGEMENT** Speaker: JOSEPH M. JURAN, Management Consultant, New York, N. Y. Subject: "Goals for Quality Management in the Next Decade" Speaker: LEONARD A. SEDER, Leonard A. Seder & Associates, Malden, Mass. Subject: "How to Evaluate a Company's Quality Control Need" Moderator: DR. A. V. FEIGENBAUM, General Electric Company, New York, N. Y	**MANAGEMENT** Speaker: WAYNE BIKLEN, American Safety Razor Company, Staunton, Va. Subject: "Quality Control Thinking Solves Overall Management Problems" Moderator: E. M. SCHROCK, American-Standard, Baltimore, Md.
B	**PRODUCT APPLICATIONS** Speaker: F. ALEX GNAEDINGER, Canadian Celanese Limited, Drummondville, Que. Subject: "Getting Started in Statistical Quality Control" For the person getting started in Statistical Quality Control, this paper emphasizes the power of statistical thinking through statement and example. Speaker: A. J. SPELICH, Waukesha Motor Company, Waukesha, Wis. Subject: "Where and When Is Quality Control Applied?" Moderator: ROCCO L. FIASCHETTI, Ansco, Binghamton, N. Y.	**MANAGEMENT** Speaker: T. C. McDERMOTT, Department of the Air Force, Anaheim, Calif. Subject: "Planning & Programming Quality Control" The author discusses the application of planning and programming techniques in the management of the control function. Moderator: E. J. LANCASTER, AMC Ballistic Missiles Center, Los Angeles, Calif.
C	**NON-PRODUCT APPLICATION** Speaker: DR. W. EDWARDS DEMING, Management Consultant, Washington, D. C. Subject: "Sampling in Consumer Research" Speaker: DR. HERBERT H. JACOBS, Dunlap and Associates, Inc. Stamford, Conn. Subject: "Operations Research in Marketing" Moderator: DR. PAUL S. OLMSTEAD, Bell Telephone Laboratories, Whippany, N. J.	**CLERICAL APPLICATION** Speaker: J. JACK INGRAM, U. S. Department of Commerce, Washinton, D. C. Subject: "Quality Control of Clerical Operations" Moderator: E. T. MAGRUDER, Chesapeake & Potomac Telephone Company, Washington, D. C.
D	**RELIABILITY** Speaker: WILLIAM A. MacCREHAN, Bendix Radio Div., Baltimore, Md. Subject: "Management's Challenge for Product Reliability" Speaker: PAUL GOLDIN, Radio Corporation of America, Camden, N. J. Subject: "How RCA Meets AGREE Test Requirements" A comprehensive review of how RCA implemented and met AGREE reliability test requirements. Moderator: AUGUST B. MUNDEL, Sonotone Corporation, Elmsford, N. Y	**RELIABILITY** Speaker: THOMAS A. BUDNE, Statistical Engineering Consultant, Great Neck, N. Y. Subject: "Reliability — A Management Problem" Moderator: H. J. BECKER, United States Steel Corporation, Waukegan, Ill.
E	**DATA PROCESSING** Speaker: WARREN G. CORGAN, Western Electric Company, Kansas City, Mo. Subject: "The Digital Computer — A Quality Control Tool" Speaker: S. A. TROXEL, Ohio Bell Telephone, Cleveland, Ohio. Subject: "A Stratified Systematic Sub-Sample Plan Selected and Evaluated on a Digital Computer" Moderator: DONALD M. SPATH, General Products Corporation, Jackson, Mich.	**DATA PROCESSING** Speaker: D. H. W. ALLAN, American Iron & Steel Institute, New York, N. Y., FRANK G. NORRIS, Wheeling Steel Corporation, Steubenville, Ohio. Subject: "Computing Equipment Used for Statistical Studies in the Metals Industry" Report on survey of members of Metals Technical Committee regarding availability and uses of computing equipment. Moderator: P. F. WADE, Price Waterhouse & Company, Montreal, Canada
F	**PRACTICAL APPLICATION** Speaker: DR. MASON E. WESCOTT, Rutgers — The State University, New Brunswick, N. J. Subject: "What's the Difference?" Speaker: ROBERT CARDNO, Canadian General Electric Co., Ltd., Toronto, Ont. Subject: "Practical Applications of Normal Probability Paper" A quality control technique for presenting graphic quality information quickly, accurately, and at low cost. Moderator: DR. J. N. BERRETTONI, Western Reserve University, Cleveland, Ohio	**PRACTICAL APPLICATION** Speaker: DR. N. L. JOHNSON, Case Institute of Technology, Cleveland, Ohio. Subject: "Choosing a Sequential Test" Moderator: DR. A. W. WORTHAM, Texas Instruments, Inc., Dallas, Texas
G	**SENSORY QUALITY CONTROL** Speaker: BENJAMIN W. MARGUGLIO, The Martin Company, Baltimore, Md. Subject: "A Quantitative Approach to Classification of Characteristics" An approach to classifying characteristics when varying degrees of non-conformance result in varying classifications. Speaker: MISS ELAINE T. ZLOBIK, General Foods Corporation, Tarrytown, N. Y. Subject: "Subjective Product Evaluation Methods" This paper is a survey of various taste test methods used in the food industry to establish differences among samples by laboratory panels and preferences by consumer panels. Moderator: HOWARD L. STIER, National Canners Association, Washington, D. C.	**SENSORY QUALITY CONTROL** Speaker: ROBERT A. BAKER, The Franklin Institute, Philadelphia, Pa. Subject: "Sensory Panel Testing" Principles of panel selection, size and training, data interpretation, and applications in the field of pollution control are examined. Moderator: L. S. EICHELBERGER, A. O. Smith Corporation, Milwaukee, Wis.

Session	MONDAY, JUNE 5 Period 4 — 3:00-4:30 P. M.	Period 6 — 10:15-11:45 A. M.	TUES Period
A	**MANAGEMENT** Speaker: WARREN PURCELL, Raytheon Company, Waltham, Mass. Subject: "Quality Cost Control" Methods of controlling quality costs will be discussed, with comments on plans, procedures, pitfalls, benefits. Speaker: RALPH KUEHN, Institute For Defense Analysis, Washington, D. C. Subject: "Quality and Reliability Management" Moderator: ALEXANDER STERNBERG, General Electric Company, Philadelphia, Pa.	**PROFESSIONAL DEVELOPMENT** Speaker: W. GORDON THOMPSON, The Champion Paper & Fibre Co., Hamilton, Ohio. Subject: "Section Liaison in Professional Development" Speaker: JOHN G. RUTHERFORD, Raytheon Co., Lewiston, Me. Subject: "Professional Licensing" An outline of the history, research and recommendation for action in the area of Professional Licensing of Quality Control Engineers. Moderator: WYATT H. LEWIS, General Electric Company, New York, N. Y.	**QUALITY CONTRO** Speaker: L. N. BRE York, N. Y Subject: "Developin gram" Moderator: PROF. I California,
B	**PRODUCT APPLICATIONS** Panel: JACK LANCASTER, AMC Ballistic Missile Center, Los Angeles, Calif. JOHN E. TRADER, Convair, San Diego, Calif. MILO HOPPER, Autonetics, NAA, Inc., Anaheim, Calif. JIM STUDDARD, Army Ballistic Missile Agency, Redstone Arsenal, Ala. CMDR. R. W. SMILEY, Bureau of Naval Weapons, Sunnyvale, Calif. Subject: "Quality Requirements in Specifications"	**PRODUCT APPLICATIONS** Speaker: RICHARD FREUND, Eastman Kodak Company, Rochester, N. Y. Subject: "Some Recent Developments in Process Control" Speaker: RICHARD S. BINGHAM, JR., The Carborundum Company, Niagara Falls, N. Y. Subject: "Statistical Methods for Ceramic Process Control and Experiment Planning" This paper aims to provide ceramic engineers and technologists with insight into ways to profit from the use of statistics in resolving process control and development problems. Moderator: OTTO A. KRAL, Minnesota Mining and Manufacturing Company, St. Paul, Minn.	**METALS** Speaker: JOHN D. Gary, Ind. Subject: "The Use ing Proces Moderator: DUNCA Steel Corp
C	**AUDITING & ACCOUNTING** Panel: DR. A. C. ROSANDER, Interstate Commerce Comm., Washington, D. C. ROBERT J. MONTEVERDE, Touche, Ross, Bailey and Smart, Pittsburgh, Pa. L. E. TEITELBAUM, Dept. of the Air Force, Washington, D. C. C. E. McMURDO, Chesapeake & Potomac Tel. Co., Richmond, Va. Subject: "The Application of Sampling and Quality Control Techniques to Accounting and Auditing"	**NON-PRODUCT APPLICATION** Speaker: JOHN B. PRINGLE, The Bell Telephone Co. of Canada, Montreal, Que. Subject: "SQC Methods in Telephone Transmission Maintenance" Discusses the application of X-Bar and R Charts in controlling trunk net loss deviations. Speaker: ERNEST LOWREY, Illinois Bell Telephone Company, Chicago, Ill. Subject: "Measuring Relay Contact Erosion" Optical method of measuring contact erosion and use of sample data to estimate contact life. Moderator: LEON BASS, General Electric Company, Cincinnati, Ohio	**INVENTORY CONTI** Speaker: ROBERT D. Coopersbu Subject: "Some Sin Control" Moderator: WILLIAM pany, Coa
D	**RELIABILITY** Speaker: CHARLES J. BREZEZINSKI, Office of Assistant Secretary of Defense, Quality Control and Reliability Div., Washington, D. C. Subject: "Reliability Requirements in Parts Specifications" Speaker: FRANCIS A. GALL, General Electric Company, Utica, N. Y. Subject: "Effective Quality Control Increases Polaris Reliability" Two methods for controlling workmanship and test procedures to effect corrective action and increase reliability. Moderator: ALLEN R. CRAWFORD, Standard Oil Company (N. J.), New York, N. Y	**RELIABILITY** Speaker: SIGMUND ZOBEL, The Carborundum Company, Niagara Falls, N. Y. Subject: "Quality Control and Reliability Organization-Professional Approach" Merits of various organizational structures for quality control and reliability activities are discussed, with examples. Speaker: J. ALFRED DAVIES, General Electric Company, Owensboro, Ky. Subject: "Life Testing for Evaluating Reliability" Moderator: HARRY W. SHIFFLETT, Texas Instruments, Inc., Dallas, Texas	**RELIABILITY** Speaker: PROF. HEN Ithaca, N. PROF. JOH Ithaca, N. Subject: "An Adapt Reliability Reliability use when th Moderator: HAROLD versity, New
E	**DATA PROCESSING** Speaker: MRS. VIDA GRACE HILDYARD, Remington Rand Univac, St. Paul, Minn. Subject: "Mechanized Retrieval of Scientific Information" Speaker: DR. MILTON TERRY, Bell Telephone Laboratories, Murray Hill, N. J. Subject: "Modern Computers in Quality Control" Moderator: DR. ENOCH B. FERRELL, Bell Telephone Laboratories, Inc., Murray Hill, N. J.	**VENDOR-VENDEE** Speaker: J. H. MOLNAR, Houdaille Industries, Inc. Buffalo, N. Y. Subject: "Vendor-Vendee Problems vs. Statistical Quality Control" Speaker: FRANK CAPLAN, JR., Westinghouse Electric Corp., Blairsville, Pa. Subject: "Incoming Inspection and Vendor Relations" Moderator: WADE R. WEAVER, Republic Steel Corporation, Cleveland, Ohio	**VENDOR-VENDEE** Speaker: DORIAN SH Mass. Subject: "Do You M in Buyer ar To help cl speaker has changes. Moderator: O. H. B Richmond,
F	**PRACTICAL APPLICATION** Speaker: FRED ENNERSON, JR., Hughes Aircraft, Tucson, Ariz. Subject: "Test Performance Charts" Speaker: EDWIN C. HARRINGTON, JR., Monsanto Chemical Company, Springfield, Mass. Subject: "Industrial Applications of Nonparametric Statistics" Frequently the assumptions underlying the usual statistical techniques are not satisfied. Nonparametric procedures provide an efficient and effective analysis of such data. Moderator: R. G. MITCHELL, The Wool "O" Company, Philadelphia, Pa.	**PRACTICAL APPLICATION** Speaker: K. S. STEPHENS, Western Electric Company, Allentown, Pa. Subject: "Versatility of Analysis of Means" Statistical validity coupled with graphical presentation make "Analysis of Means" an extremely valuable tool for analyzing experimental designs. Speaker: RICHARD DE GRAY, The Standard Oil Company, Cleveland, Ohio. Subject: "Keep It on the Square" Moderator: DR. FRED C. LEONE, Case Institute of Technology, Cleveland, Ohio	**BULK SAMPLING** Speaker: DR. ACHES University, Subject: "Some Comm of Bulk Mat Moderator: ALBERT Technology,
G	**MISCELLANEOUS** Speaker: CHARLES HIRSCH, The Golden Nugget, Las Vegas, Nev. Subject: "Quality Control Techniques in Casino Operations" Speaker: NORMAN E. SALMONS, Eastman Kodak Company, Rochester, N. Y. Subject: "Improving the Quality of Technical Illustrations" Moderator: JOSEPH E. BEEZER, Radio Corporation of America, Camden, N. J.	**SENSORY QUALITY CONTROL** Speaker: PETER VAN S. RICE, A. H. Rice Company, Pittsfield, Mass. Subject: "Putting the Senses To Work in Quality Control" Discussion of the technical and administrative problems associated with nonnumerical standards for process and product quality. Speaker: C. KENNETH DIVERS, Brown-Line-Chapin Div., GMC, Syracuse, N. Y. Subject: "Statistical Aids to Visual Inspection" Moderator: W. R. REEVES, Radio Corporation of America, Camden, N. J.	**VALUE ANALYSIS** Speaker: LARRY MI Schenectady Subject: "Value Anal Moderator: RALPH

ENTION PROGRAM

, JUNE 6		WEDNESDAY, JUNE 7
:30-2:30 P. M.	Period 8 — 3:00-4:30 P. M.	Period 10 — 10:15-11:45 A. M.
ING eral Electric Company, New ality Control Education Pro- P. COLEMAN, University of geles, Calif.	**QUALITY CONTROL TRAINING** Panel: PAUL C. CLIFFORD, Montclair State Teachers College, Montclair, N. J. R. S. BINGHAM, JR., The Carborundum Company, Niagara Falls, N. Y. HARMON S. BAYER, Bayer, Kobert & Associates, Inc., Detroit, Mich. Subject: "Variability in QC Training"	**MANAGEMENT** Speaker: ALLIN DEACON, Deacon Associates, Brantford, Ont. Subject: "Total Quality Control in Smaller Industries" Quality Control is a paying proposition if it permeates engineering, purchasing, sales and service as well as manufacturing. Speaker: EDWARD M. BRABANT, Blackhawk Mfg. Company, Milwaukee, Wis. Subject: "Does Small Business Need Quality Control?" Moderator: PAUL A. ROBERT, KDI Corporation, Norwood, Ohio
, U. S. Steel Corporation, tionary Operations for Study- mon to the Steel Industry" McCUNE, Jones & Laughlin Pittsburgh, Pa.	**PRODUCT APPLICATION** Speaker: H. MACK TRUAX, Atlas Powder Company, Wilmington, Del. Subject: "An Introduction to Cumulative Sum Charts" Speaker: TRUMAN KOEHLER, American Cyanamid Company, Bound Brook, N. J. Subject: "Methods of Process Improvement" Moderator: DR. J. S. HUNTER, Army Ordnance Math. Research Center, Madison, Wis.	**TEXTILE** Speaker: N. L. ENRICK, University of Virginia, Charlottesville, Va. Subject: "Variations Flow Analysis For Process Improvement" A technique for evaluating and reducing the transfer of variations in stock is described, using actual data. Speaker: CHARLES D. FERRIS, Mohasco Industries, Amsterdam, N. Y. Subject: "Rating Appearance Quality of Carpet" Construction of an appearance quality index and presentation of company and competitive data. Moderator: WALTER F. PRIEN, Philadelphia College of Textiles and Science, Philadelphia, Pa.
ND, Kurt Salmon Assoc., Inc., atistical Tools for Inventory EPBURN, Lukens Steel Com- Pa.	**OPERATIONS RESEARCH** Speaker: GEORGE W. GERSHEFSKI, Standard Oil Company, New York, N. Y. Subject: "New Departures for Operations Problems" Speaker: WILLIAM A. GOLOMSKI, H. J. Mayer & Sons Co. Inc., Chicago, Ill. Subject: "Queuing Theory and Applications with Emphasis on Food Industries" Moderator: MAX ASTRACHAN, The Rand Corporation, Santa Monica, Calif.	**NON-PRODUCT APPLICATION** Speaker: DR. GLENN GILMAN, Lockheed Research Laboratory, Palo Alto, Calif. Subject: "The Human Equation in Quality Control" Speaker: GEORGE ENDRICH, General Electric Company, Syracuse, N. Y. Subject: "A Foundation for Professional Action" Basic Work Elements aid in developing a quality system. Certain occupational specialties comprise the totality of Quality Control Engineering. Moderator: ROBERT SCHIN, Western Electric Company, Grandview, Mo.
GOODE, Cornell University, K. KAO, Cornell University, f the MIL-STD-105B Plans to e Testing Applications" g tables and procedures for bution is of the Weibull form. DGE, Rutgers — the State Uni- ck, N. J.	**RELIABILITY** Speaker: RICHARD H. MYERS, Hughes Aircraft Co., Culver City, Calif. Subject: "Which Road to Satellite Reliability" This paper outlines the reliability program plan needed to meet the severe reliability requirements of satellite systems. Speaker: FRANK M. GRYNA, JR., The Martin Company, Baltimore, Md. Subject: "Reliability Instrument Panel" Elements of reliability control including a method of reporting performance of reliability tasks are discussed. Moderator: M. W. ROGERS, Radio Corporation of America, Moorestown, N. J.	**RELIABILITY** Speaker: FRANK SINDELAR, I.B.M. Corporation, Poughkeepsie, N. Y. Subject: "Product Performance Measurement" Precise measurement of a product performance in the customer's environment, provides final verification of in-plant process controls. Speaker: W. J. HUBER, Sperry Gyroscope Company, Garden City, N. Y. Subject: "Product Performance Assurance" Product performance assurance is the controlling of all parameters that affect product performance under operational conditions. Moderator: REESE P. DAVIS, Taylor Fibre Company, Norristown, Pa.
, Rath & Strong, Inc., Boston, ese Quality Control Mistakes er Relations?" improve these relations, the introduce several unorthodox , Reynolds Metals Company,	**MILITARY** Speaker: HERBERT B. EPSTEIN, Vought Electronics, Dallas, Texas. Subject: "A Contractor Writes a Military Specification" This paper discusses the Polaris quality requirements written for the Navy by a contractor. Speaker: RENE LA BONTE, Military Clothing & Textile Supply Agency, Philadelphia, Pa. Subject: "Quantity with Confidence" MCTSA quality control techniques minimize red tape and expedite acceptance under normal and emergency conditions. Moderator: ARNOLD K. DODDS, JR., U. S. Signal Corps Supply Agency, Philadelphia, Pa.	**MILITARY** Panel: LT. COL. WILLIAM E. HUGHES, Standardization Div., DCS/Log., Washington, D. C. COL. R. M. STOLLE, Wright-Patterson AFB, Dayton, Ohio. VICE ADMIRAL G. R. BEARDSLEY, Office of Naval Material, Washington, D. C. Subject: "Department of Defense Progress in Quality Control and Reliability for 1960"
UNCAN, The Johns Hopkins re, Md. on the Sampling and Analysis KMERS, Rochester Institute of ster, N. Y.	**PRACTICAL APPLICATION** Speaker: GORDON BECKHART, R. C. A., Moorestown, N. J. Subject: "Short-Cut Statistical Methods" Speaker: R. B. MURPHY, Bell Telephone Laboratories, New York, N. Y. Subject: "Hunting and Taming the Wild Observation" Avoiding or finding wild observations requires technique. If found, they require evaluation. Moderator: H. DEAN VOEGTLEN, RCA Service Company, Riverton, N. J.	**RESEARCH & DEVELOPMENT** Speaker: CHARLES A. BICKING, The Carborundum Company, Niagara Falls, N. Y. Subject: "Designing Valid Experiments" In designing experiments, general principles are important rather than a few pat patterns. Speaker: MRS. ELIZABETH ROSS, Aeroprojects Inc., West Chester, Pa. Subject: "Response Surface Techniques as a Statistical Approach to Research and Development in Ultrasonic Welding" Moderator: MISS BESSIE B. DAY (MAUSS), Bureau of Ships, Washington, D. C.
General Electric Company, d Engineering" REHAM, Chappaqua, N. Y.	**RESEARCH & DEVELOPMENT** Speaker: ROBERT G. FITZGIBBONS, Raytheon Co., Wayland, Mass. Subject: "Quality Control in Research and Development" Speaker: JERRY BRAVERMAN, Frankford Arsenal, Philadelphia, Pa. Subject: "Controlling Quality in the Production-Engineering Climate" Description of a quality control system applied to initial production runs. Moderator: J. F. TEUNISSON, Federal Aviation Agency, Washington, D. C.	**MANAGEMENT** Speaker: WALTER HAYTER, The Youngstown Sheet & Tube Co., East Chicago, Ind. Subject: "Process and Quality Control for Management" Speaker: K. R. WILLHITE, Rocketdyne, Canoga Park, Calif. Subject: "Maximizing the Quality Control Effort" Moderator: WILLIAM E. BRAMER, Colorado Fuel & Iron Corporation, Trenton, N. J.

15TH ANNUAL
CONVENTION PROGRAM

WEDNESDAY, JUNE 7

Session	Period 11 — 1:30-2:30 P. M.	Period 12 — 3:00-4:30 P. M.
A	**MANAGEMENT** Speaker: AXEL STERNLOF, American Steel and Wire Company, Worcester, Mass. Subject: "A Challenge to Labor and Management" This paper is a frank presentation of a "touchy" subject in American industry: Labor-Management-Production and Quality. Moderator: C. R. HASTINGS, Allegheny Ludlum Steel Corporation, Watervliet, N. Y.	**MANAGEMENT** Speaker: CHESTER H. McCALL, JR., Booz-Allen Applied Research, Bethesda, Md. Subject: "Breadth or Depth? — Training for Quality Control and Operations Research" The unique and common requirements in training are described with emphasis on some controversial aspects. Speaker: DONALD G. MALCOLM, Operations Research, Inc., Los Angeles, Calif. Subject: "Operations Research in Management" Operations research studies are directed either to specific problem solving or to management system design. Discussion of latter use will be emphasized. Moderator: R. H. EDE, United States Steel Corporation, Chicago, Ill.
B	**TEXTILE** Speaker: S. PETER SPALDING, C. F. Hathaway Company, Waterville, Me. Subject: "A Practical Analysis of a Successful SQC Installation In High Quality, High Style Apparel Manufacturing" The installation and evaluation of the quality program at Hathaway, a high quality garment manufacturer. Moderator: MAJOR HARLAN W. TUCKER, Military Clothing & Textile Supply Agency, Philadelphia, Pa.	**TEXTILE** Panel: J. B. CURLEY, American Viscose Corporation, Marcus Hook, Pa. JOHN M. GOULD, The Barre Wool Combing Co., Inc., South Barre, Mass. STANLEY BREEN, Forte Engineering Company, Norwood, Mass. R. L. OVERCASH, American Viscose Corp., Marcus Hook, Pa. Subject: "New Methods of Controlling Moisture — Textile Materials"
C	**NON-PRODUCT APPLICATION** Speaker: MISS BONNIE B. SMALL, Western Electric Company, Allentown, Pa. Subject: "Extension Uses of S. Q. C." Moderator: F. BRUCE MAY, ACF Industries, New York, N. Y.	**NON-PRODUCT APPLICATION** Speaker: DR. MORRIS HAMBURG, University of Pennsylvania, Philadelphia, Pa. Subject: "Bayesian Decision Theory and Statistical Quality Control" The relationship of Bayesian decision theory to traditional hypothesis testing procedures and statistical quality control. Speaker: PROF. WALLACE RICHARDSON, Lehigh University, Bethlehem, Pa. Subject: "Work Sampling" Moderator: DR. S. S. WILKS, Princeton University, Princeton, N. J.
D	**RELIABILITY** Speaker: CLIFF RYERSON, Radio Corporation of America, Camden, N. J. Subject: "Myths and Realities in Reliability" Moderator: IRVIN W. SCHOENINGER, Globe-Union, Inc., Milwaukee, Wis.	**RELIABILITY** Speaker: H. I. DWYER, JR., The Bendix Corporation, Cincinnati, Ohio. Subject: "Electronics Reliability — A Mechanical Problem" A discussion of why structure, environments and people cause more electronic unreliability than electrical problems. Speaker: ANTHONY DRUMMOND, ARINC Research Corporation, Washington, D. C. Subject: "Optimization of Equipment Effectiveness" A discussion of the development of techniques for maximizing equipment effectiveness through reliability and maintainability studies. Moderator: K. L. JONES, Beech Aircraft Corporation, Wichita, Kan.
E	**MILITARY** Speaker: SAMUEL S. J. SKOLNIK, Military General Supply Agency, Richmond, Va. Subject: "Quality Control — the Evolution of an Occupation" Moderator: CHARLES A. BICKING, The Carborundum Company, Niagara Falls, N. Y.	**MILITARY** Panel: CMDR. J. A. BARKER, Bureau of Ships, Washington, D. C. S. J. LORBER, Office of the Chief of Ordnance, Dept. of the Army, Washington, D. C. R. P. HUSSEY, Quality Control and Reliability, Office of Production Policy, Supply and Logistics, Washington 25, D. C. Subject: "Procurement Cost and Reliability"

PLANT TOURS

Monday, June 5, 1:30 P. M.

Smith, Kline and French Laboratories

These laboratories are equipped with the latest in automated and controlled equipment for the processing of pharmaceuticals to maintain the high qualities so essential in this field.

Tuesday, June 6, 10:00 A. M.

Textile Laboratories
Military Clothing and Textile Supply Agency

A tour of the most complete and finest textile laboratories in the world. This visit will provide a rare opportunity for those members in the textile field.

Tuesday, June 6, 1:30 P. M.

Standard Pressed Steel Co. — Jenkintown

Manufacturers of fasteners that the Aircraft Industry swears by, not at. AOQL of 0.14% on overall production, including government and commercial shipments. Tour should be of particular interest to members in metals and aircraft industries.

Tuesday, June 6, 1:30 P. M.

Radio Corporation of America — Moorestown

A must for members interested in electronics. Life testing of electronic components and the reliability of their application to such items as missiles that cannot be recovered for analysis.

Quality Control in the Quaker City

INSPECTIONEERING WORKSHOP PROGRAM

MONDAY, JUNE 5

Moderator: HARRY M. BEAR, U. S. Gauge Div., American Machine and Metals, Inc., Sellersville, Pa.

10:15-11:00
Speaker: PATRICK J. NELLIGAN, Thompson-Ramo-Wooldridge, Inc., Minerva, Ohio.
Subject: "A Survey of Visual Inspection"
Selection and training of quality control personnel — The key to a successful quality control program — Some old and new techniques.

11:15-12:00
Panel: ALBERT A. GOODMAN, Yale and Towne Mfg. Co., Philadelphia, Pa.
STANLEY S. HART, The Esterbrook Pen Co., Camden, N. J.
DAVID K. SNODGRASS, Leeds and Northrup Co., Philadelphia, Pa.
Subject: "Measuring Your Inspectors' Productivity"

1:30- 2:30
Panel: ROMAN E. BORUTA, Chrysler Corp., Trenton, Mich.
ROBERT G. MITCHELL, Wool-O Company, Philadelphia, Pa.
STANLEY B. SHERWOOD, General Motors Tech. Center, Warren Mich.
Subject: "Cost of Inspection"

2:45- 3:45
Speaker: EVERETT DALE, Minneapolis-Honeywell Reg. Co., Minneapolis, Minn.
Subject: "Organization of the Inspection Function for Maximum Effectiveness"
Significant parameters of inspection function operation in the design and manufacture of aerospace systems.

4:00- 5:00
Panel: CARL D. LARSON, General Tire and Rubber Company, Logansport, Ind.
NORMAN MILLER, Frankford Arsenal, Philadelphia, Pa.
RALPH E. WAREHAM, Mngt. Consultant, Chappaqua, N. Y.
Subject: "Inspection Trouble Shooting"

TUESDAY, JUNE 6

Moderator: HARRY M. GREINER, Radio Corporation of America, Moorestown, N. J.

10:15-11:00
Speaker: EDWARD R. CLOSE, Bausch & Lomb, Rochester, N. Y.
Subject: "A Survey of Visual Inspection"
The visual inspection system is analyzed to show how accuracy can be improved and cost reduced.

11:15-12:00
Speaker: DORIAN SHAININ, Rath and Strong, Boston, Mass.
Subject: "Future Outlook For Inspection"

1:30- 2:30
Panel: DOUGLAS CUNNINGHAM, Standard Gage Co., Inc., Poughkeepsie, N. Y.
WILLIAM ARNOLD, SKF Industries, Philadelphia, Pa.
FRANK DIXSON, Standard Pressed Steel Co., Jenkintown, Pa.
MURRAY DWIGHT, Dwight Instrument Service, Lyndhurst, N.J.
Subject: "Dial Gage Maintenance and Repair"

2:45-3:45
Speaker: FRANK CAPLAN, JR., Westinghouse Electric Corp., Blairsville, Pa.
Subject: "Simplifying Inspector's Reports"

4:00- 5:00
Speaker: STANLEY WIRTSCHAFTER, U. S. Gauge Div., American Machine and Metals Inc., Sellersville, Pa.
Subject: "Statistics Made Easy For Inspectors"

WEDNESDAY, JUNE 7

Moderator: EDWARD HADEN, Esterbrook Pen Co., Camden, N.J.

10:15-11:00
Speaker: SEYMOUR J. LORBER, Department of Defense, Washington, D.C.
Subject: "What Inspectors Should Know About Sampling"

11:15-12:00
Panel: MICHAEL C. CURTIS, Timken Roller Bearing Co., Canton, Ohio
DAVID B. KIRK, Moore Products Co., Philadelphia, Pa.
DANIEL H. MOIR, Ford Motor Co., Dearborn, Mich.
Subject: "Limitations of Gages"

1:30- 2:30
Panel: MELVIN FREUTENICHT, U. S. Army Ordnance Gage Lab., Philadelphia, Pa.
IRVING H. FULLMER, National Bureau of Standards, Washington, D. C.
STANLEY F. MUNDY, Taft-Peirce Mfg. Co., Woonsocket, R. I.
JOHN B. TWINING, Standard Pressed Steel, Jenkintown, Pa.
Subject: "Screw Thread Methodology"

2:45- 3:45
Speaker: RUSSELL E. LEITCH, Ind. Psychologist, Philadelphia, Pa.
Subject: "Industrial Psychology in Relation to Product Quality"

4:00- 5:00
Panel: WAYNE G. NORTON, Optical Gaging Products, Rochester, N.Y.
COL. W. J. DARMODY, RET., Sheffield Corp., Dayton, Ohio.
L. E. HENRYSON, Moore Products Company, Philadelphia, Pa.
ROBERT A. DANA, Hamilton Watch Co., Lancaster, Pa.
Subject: "Advanced Trends in Gaging"

LIST OF EXHIBITORS AND DESCRIPTIONS

American Cystocope Makers, Inc.
Boonshaft & Fuchs, Inc.
Brown & Sharpe Mfg. Co.
Convair, A Division of General Dynamics Corp.
Diversa Electronics Corp.
Elliott Service Co.
Federal Products Corp.
Friden, Inc.
General Electric Co., Specialty Control Department
Hunter Associates Laboratory, Inc.
The Martin Co.
Monroe Calculating Machine Co.
Moore Products Co.
Rototest Laboratories, Inc.
Standard Gage Company, Inc.
Testing Machines, Inc.
Thwing-Albert Instrument Co.
United States Air Force
United States Army
United States Navy

Booth 104

STANDARD GAGE COMPANY

Products to be exhibited may be divided into two categories — mechanical gaging and air gaging.

The mechanical display will consist of Standard's Adjustable Dial Indicating Bore Gages, AGD and Special Dial Indicating Snap Gages, Adjustable Dial Indicating Shallow Diameter Gages, AGD Dial Indicators and Standard's Thread Measuring, Dial Indicating Pitch Diameter Comparators.

The Air Gage section of our display will feature two operating models of our Air Gaging Stands (Models No. 120 and 240), with an Adjustable Airbore Gage hook-up, an Airplug hook-up, and Adjustable Air-Snap Gage, the complete selection of "clip-on" dial magnifications that can be used with each stand, Standard's three types of gaging cartridges and Standard's "Span-Setting" Masters.

Booth 111

BOONSHAFT AND FUCHS INC.

Two products to be exhibited are:

STATISTIC-desk-top computer for statistical calculations, and

On-line STATISTICAL Computer for continuous indication and/or recording of mean value and standard deviation of production processes.

The second item is a brand new device which will be shown for the first time at the Convention. Literature is not yet available, but briefly, the unit takes a voltage input from a measuring device such as a thickness gage and continuously indicates and/or records the mean value and standard deviation.

Booth 112

HUNTER ASSOCIATES LAB., INC.

Exhibiting: Hunterlab D25 Color Difference Meter for tristimulus values of color and small color differences: direct-reading color-difference attachment will be demonstrated; D40 Reflectometer for whiteness, reflectance, yellowness, opacity and fluorescent whitener evaluation; D16 Glossmeter for 20°, 45°, 60°, and 75° tests of paints, papers, plastics, fibers; new D36 Distinctness-of-Image Glossmeter for mirror image quality of high-gloss surfaces.

Booth 120

TESTING MACHINES INC.

The following items will be included in the TMI exhibit:

Diatest High Precision Small Bore Measuring Gage, a high precision gage available in several ranges for

accurately measuring tapered bores, incomplete bores, barrel-shaped bores, out-of-round bores and bores where other bores interfere.

TMI Motorized Dead Weight Micrometer, for precision measurement of compressible sheet materials.

Portable Rockwell Hardness Tester, which uses standard Rockwell loads and indentors for testing large sheets, bar stock, etc. (on location).

Electronic Micro Hardness and Electronic Micro Indentation Testers, for high precision measurement for rubber, plastics, paints and lacquers.

Dynamic Impact and Bursting Strength Tester for evaluating paper or plastic sheet materials under low and high temperatures.

Miscellaneous Force Measuring and Inspection Devices, symbolic of the more than 1237 testing devices.

Reservations will also be accepted from qualified technical directors and purchasing executives for the new TMI Catalog and Register of Testing Machines, which will be available in July.

Booth 123

THWING-ALBERT INSTRUMENT CO.

Thwing-Albert will exhibit a complete line of tensile strength testing equipment. The pendulum type tensile testers will be represented by our Models 37-4 and 30LT. The electronic Models 49RC and 30RC will also be on display. Grips and fixtures for use in making a wide variety of tests on these instruments will be shown.

In view of the increasing recognition of the importance in testing of accurate samples, we will exhibit our complete line of precision sample cutters which include the following:

Model JDC for preparing parallel strips; Catalog 98 for preparing parallel strips for the Elmerdorf Test.

Catalog No. 240-3 Alfa Cutter, toggle action and Catalog No. 240-4 Hydraulic Alfa Cutter with an assortment of typical steel rule dies for preparing samples including irregular shapes.

Catalog No. 97-1 Four Square Cutter for preparing samples exactly one foot square.

Other instruments to be displayed are:

Catalog No. 60-400 Elmerdorf Tearing Tester with two Augmenting Weights to provide capacity from paper to textiles.

Catalog No. 60-508 Elmerdorf Tearing Tester having a light pendulum and two augmenting weights providing capacities from 200 grams to 800 grams for materials too weak for the 1600 gram capacity of the heavier model.

Catalog No. 72-1 Spencer Attachment to the Elmendorf Tearing Tester for making impact tests.

Catalog No. 140-1 Densitometer.

Catalog No. 211-3 Handle-O-Meter for softness measurements of textiles and other materials.

Catalog No. 225-3 Egan Slip Tester for sheet materials.

Booth 124

MOORE PRODUCTS COMPANY

Moore Products will exhibit pneumatic comparator gages for manual inspection, automation building blocks for machine control and automation gaging, gaging recorder for quality control applications, and Moore gaging cartridges for "build your own" fixturing.

Booths 135-136

HOLCO

The general theme for this exhibit will be precision gaging for quality control with emphasis on cost reduction.

The exhibit will include: American Optical Cycloptic Microscope; Argus Hite-Check; Bryant Rock-of-Ages True Granite Surface Plates; Bryant Thread, Groove, Bore Gages; Cadillac Pla-Chek, Bore Set; Davidson Optronics Automatic Auto-collimator, Plano-Interferometer.

Ex-Cell-O Contour Projector; Ex-Cell-O Pneumatic Indicator Stand; Gaertner Scientific Toolmaker's Microscope; Hamilton Kwik-Chek Mechanical and Electric Indicator Gages; National Borescope; Robbins Magna-Sine Sine Plates; Robbins 90° Indicator Gage; Optical Gaging Products Inc.

Booth 151

ENCYCLOPEDIA BRITANNICA

World famous. So fascinating, so different. Unlike anything else. The brand new edition of Encyclopedia Britannica is dramatically alive in color. Thousands of new articles. Now on display for your inspection at Booth 151.

We have something special for you, so don't fail to ask about it.

Booth 152

COULTER ELECTRONICS, INC.

Coulter Electronics, Inc., will exhibit particle size analysis equipment for determination of size distributions for most powdered or slurried fine particle materials. The Model "A" will be exhibited. This unit electronically counts particles up to the rate of 5000 per second, in the size range from ½ micron to over 200 microns.

Booth 154

MAGNAFLUX CORPORATION

The following nondestructive testing equipment and services will be represented in our booth: Magnaflux and Magnaglo, magnetic particle testing; Spotcheck, dye penetrant testing; Sonizon, resonate ultrasonic test for thickness; Magnetest, eddy current instruments to find cracks, measure conductivity, and sort according to hardness or alloy; Bondcheck, thermographic test to locate lack of braze in honeycomb structures.

Booths 171-172

ELLIOTT SERVICE CO., INC.

A *brand new* exhibit featuring:

HI-VISION QUALITY PROGRAM

Designed to secure and hold employee cooperation in the twin fields of quality improvement and waste reduction. A visual means of moving minds towards plant quality objectives.

MANAGEMENT INFORMATION

A weekly bulletin for Supervisors and Foremen. Designed to provide job help and develop leadership qualities. Includes "human relations" guidance and a practical approach to supervisory planning.

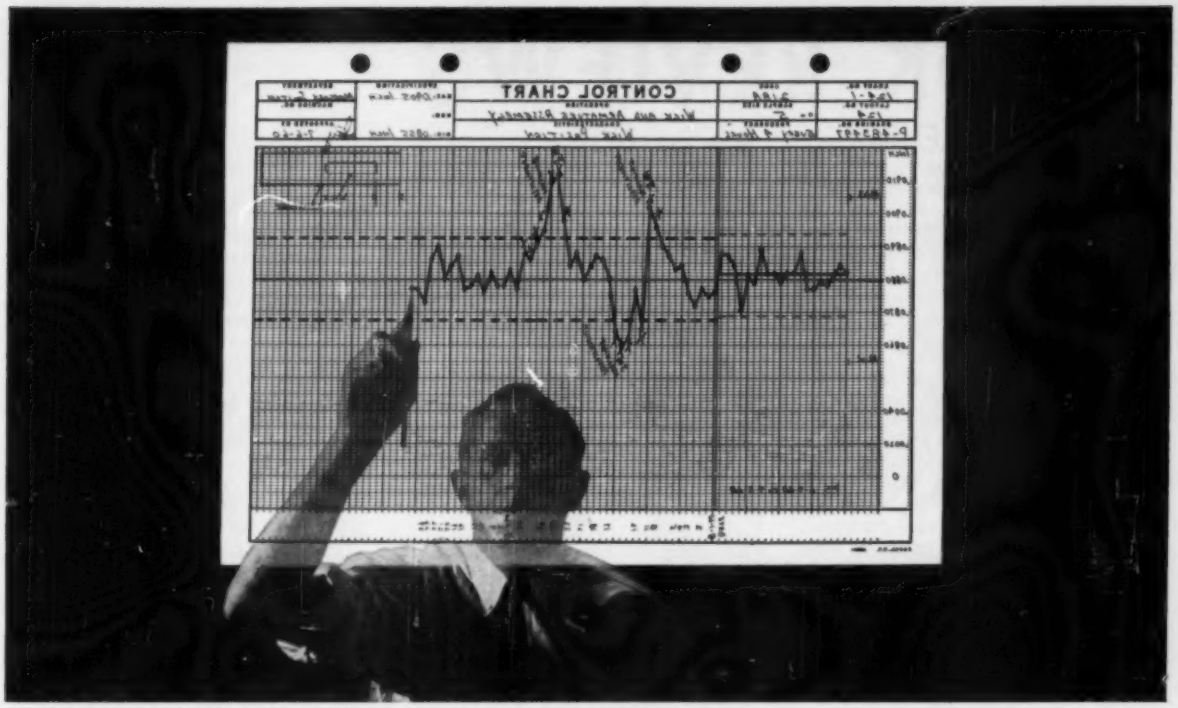
SUGGESTION SYSTEM SERVICE

Complete working material and equipment for operating a successful suggestion plan. Includes colorful, effective publicity for securing quality and quantity suggestions.

Booth 177

AMERICAN CYSTOSCOPE MAKERS, INC.

American Cystoscope Makers, Inc., will exhibit Borescopes, Fiber Optic Borescopes, and Miniature Lamps.



Statistical Quality Control charts, as used by Western Electric to detect abnormal influences affecting the manufacturing processes, are an important part of quality control procedures.

HOW W.E. APPLIES SQC

A pioneer in the application of Statistical Quality Control over 30 years ago, Western Electric today uses SQC at all its major manufacturing locations to increase the yield of quality products from its thousands of manufacturing processes.

Western Electric's 228-pg. SQC Handbook—a reference work dealing with industrial applications of Statistical Quality Control.

The Company's SQC engineers work with design engineers to make sure that the process required to manufacture a certain item will have statistical control limits compatible with design specifications. Once the process is developed, it is tested statistically to determine the actual control limits and prepare control charts.

When a process is trouble-free, points representing random samplings of the product tend to fall above and below the centerline — but within the control limits represented by the parallel dotted lines in the illustration above.

Sample points falling either outside or consistently near the control limits are marked with X's on the chart to denote abnormal factors present in the process. Certain unnatural patterns indicate undesirable influences, which could be substandard piece parts or raw materials, a worn machine, a change in processing methods, an inexperienced operator, or a host of possible variables.

A detailed analysis of the control chart lets Shop Supervision, Quality Control Engineering, and Product Engineering personnel isolate and correct abnormal factors with minimum costly down-time and defective product. The control chart is used also in more complicated statistical analyses to solve engineering problems involving more elusive causes of abnormal variation, and in new processes to determine the correct combination of conditions to yield the best results.

SQC, in combination with a system of quality auditing, helps Western Electric maintain the uniformly high quality of products that pays off in reliable and economical telephone services throughout the Bell System network.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

BOOK REVIEWS

W. D. Baten, Editor
26 University Drive, East Lansing, Mich.

BASIC STATISTICS FOR BUSINESS ECONOMICS by C. F. Smith and D. A. Leabo, published by Richard D. Irwin, Inc., Homewood, Ill., $6.00, vii-301 pages. Reviewed by Dr. E. E. Ingalls, Albion College, Albion, Mich.

A clearly written and readable text with an excellent choice of topics for a course in Business Statistics. As well as explaining the "why" of statistical methods, emphasis is placed upon the use of these methods in reaching business decisions. Warnings, really cautions, are given so that the student will not misuse these methods.

Among the many excellent aids which are given, the following deserve special mention — list of symbols at the beginning of chapters, summaries and warnings, chapter bibliographies, an excellent chapter on sources of basic data.

The chapters on tabular and graphic presentation, frequency distributions, averages and dispersion are written so that these topics are understandable by a student who has had only elementary mathematics.

Sample surveys supply information for intelligent decisions in the management of business.

A reader familiar with quality control methods will recognize some of the material in the chapters headed, "Collection of Original Data" and "Statistical Reasoning and Inference."

The authors discuss with illustrative problems the usual types of samples including simple random and stratified random samples; systematic samples; quota controlled samples. The discussion is well worked out and is worth reading to compare with methods used in Quality Control.

Methods of data collection using personal interviews, mail, telephone, or panels to reach the respondent are compared with respect to cost, non-responses, representation of the population being sampled and sample size.

The material used for statistical inference is limited to large samples from large populations.

Index Numbers are used — to compare the production of one firm with that of similar firms, to study past changes in market conditions, cost of living, etc. After methods of computing the usual index numbers from simple, assumed data, the text discusses the limitations imposed by the method of computation as well as by the choice and availability of the items used for the making of index numbers. Some important index numbers are critically examined.

A business executive needs a basis for long-range planning — buildings, equipment, expansion, etc. He also needs a basis for short range planning — purchasing of raw material, amount of product or products to be manufactured, etc.

To provide this information the text considers in the chapter on the analysis of time series, the effect of four forces — secular trend, (long-term change), seasonal variation, cylical variation, irregular (or random) variation. Using examples, methods are given for estimating three of these factors. The comments, cautions and warnings which are given are pertinent and valuable.

It is interesting to see that correlation is explained first by using the line of regression. As this is an extension of the method of straight line trend used in the chapter on analysis of time series, material from two chapters are related in the mind of the reader.

From reading the chapters on sampling, time series and index numbers, an appreciation would be gained of what a "business" statistician is concerned with and considers important.

REGRESSION ANALYSIS by E. J. Williams, John Wiley & Sons, Inc., New York, N.Y., $7.50, 1959, ix-214 pages. Reviewed by W. D. Baten, Michigan State University.

This book opens with a presentation of straight line regression, standard errors of the constants, tests of their significance and analyses of variances for carrying out these tests.

Multiple linear and curvelinear regressions are explained where inverse matrices are employed for calculating coefficients and their standard deviations together with appropriate analyses of variance for testing. Here is shown how to determine the importance of adding or deleting an independent variable. Matrices play an important part in all chapters. Corrections are given for an adjustment in the value of one variable to allow for the effect of the variation in another. Orthogonal polynomials are treated together with regressions when the coefficients are dependent upon various variables or conditions.

Chapter 4 treats of regression equations of the form $y = b_0 + b_1 f(x,c)$, where f is non-linear in c. By choosing values of c the values of f(x,c) can be calculated and used to find the regression equation after two or three adjustments to c. This section explains the fitting of exponential regressions, fitting of hyperbolic regressions, linear regression with weights and estimation by maximum likelihood.

In the next chapter, Hotelling's method of determining which of two independent variables is better for predicting the dependent variable test of significance of regression through the origin and the comparison of two regression equations are discussed.

Chapter 6 presents estimating predicted values from linear and nonlinear equations with fiducial limits, estimation of zeros and maximas of fitted curves.

This is followed by ideas about covariance analysis which involves testing averages of "treatments" after adjusting because of relations to other variables.

Chapter 8 presents material concerning regressions pertaining to sets of data where the independent variables are the same for each set. By analyses of variance it is shown how to test whether or not the regressions are parallel and a common regression may be used for all sets. The author then describes how an analysis of variance can be used to test whether several regression lines are concurrent and also when the predicted value of the dependent variable is significant from the ordinate of the point of concurrence.

Following is a presentation of simultaneous regression equations where there are several independent variables and several dependent variables. This should open up many applications for industry.

Chapter 10 treats of discriminant functions where a compound, pertaining to one "treatment," consist-

Statistical Methods Courses in August

University of California Extension "Statistical Methods in Industry" courses which will be run concurrently from 8:15 to 4:45, Monday through Friday, July 31 to August 11, are quality control by statistical methods, industrial statistical methods, statistical design and analysis of industrial experiments, engineering and management of reliability, basic electrical measurements and standards, and fundamental principles of nondestructive testing.

ing of several variables, is compared with another compound consisting of the same variables for another "treatment." A discriminant function is found which consists of the difference of the means of the two compounds. An analysis of variance of these compounds is carried out to determine whether or not the compound averages are significant.

The last chapter deals with functional relations where the independent "variables" are not errorless.

The author gives examples in every chapter to illustrate the meaning of the material presented, the necessary computations for analyses and appropriate interpretations.

This well written book has brought together many excellent ideas on regression that have been found in various publications and furnishes a text that will prove beneficial to students of this subject.

STATISTICAL THEORY OF SIGNAL DETECTION, by Carl W. Helstrom, Pergamon Press, New York, N.Y., 1960. 364 p., diagrs. 22 cm. (International series of monographs on electronics and instrumentation, Vol. 9). Price $9.50. Reviewed by Dr. Robert Price, Lincoln Laboratory, Massachusetts Institute of Technology.

Beginning in the early 1940's with Wiener's classic treatment of the filtering of stochastic time series, the field of statistical communication theory has made sound and steady progress until today it is widely accepted as a powerful discipline of particular import to the electronic systems engineer. Indeed, it can be said that no modern study of the behavior and significance of information-bearing signals in actual electronic systems is complete without due attention to statistical concepts.

Following Wiener's achievement, the second milestone along the way to the present state of accomplishment came in 1948 when Shannon laid the foundations of information theory. Here formal recognition and quantitative expression were for the first time given to the philosophy stated above that informational processes should be described and evaluated in statistical terms. At the same time, the more obvious pertinence of statistical analysis to random system disturbances was clearly reiterated. Most importantly, the fundamental achievements of Shannon were no mere "unification," but broke new ground and pointed to previously unknown communication possibilities whose realization is even now challenging many brilliant minds.

The third major accomplishment in statistical communication theory is not associated exclusively with the names of any one or two men, but was nourished over a couple of decades, beginning in 1933 with the formulation of hypothesis testing by Neyman and Pearson. The contributions of Wald, Siegert, Woodward and Davies, Middleton and Van Meter, and Peterson, Birdsall and Fox, were instrumental in bringing the theory of hypothesis testing to the point where it is now readily applicable to the design of efficient electronic receiving and data processing apparatus, and also, to a somewhat lesser extent, to the selection of effective transmissions. It is interesting that in 1947, almost unnoticed by the West, Kotel'nikov published in Russia a doctoral dissertation, in which he developed this hypothesis-testing approach to a surprising degree of refinement, much as Kolmogorov had paralleled Wiener's work a few years before.

Although the theory of hypothesis testing, as it presently applies to electronic systems, is completely compatible with and overlaps Shannon's information theory (the extent of overlap is a topic of polite controversy), it has come to fruition largely apart from information theory, and indeed has significant scope outside of information theory, particularly in radar. Therefore this third sub-discipline of statistical communication theory has been duly designated as statistical detection (or, by some authors, decision) theory; devices that evolve from the application of hypothesis testing are frequently called optimum detectors. Dr. Helstrom's book is concerned with this branch of statistical communication theory.

A fourth area of endeavor, that is essential to the explicit implementa-

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tion of the preceding three, is the analysis of signal and noise waveform statistics. Here Rice, starting in 1944, and later Middleton, have led the development of appropriate mathematical tools and have found key results.

For a balanced perspective and a realistic appreciation of the potentialities of statistical communication theory, one should be familiar with all four subdisciplines: filtering theory, information theory, statistical detection theory, and noise analysis. The recent books of Davenport and Root[1] and Middleton[2] give considerable attention to statistical detection theory, and deal as well with noise analysis and filtering theory. While the treatment by Davenport and Root is admirable as a class text, Middleton's is exhaustively comprehensive and is an excellent reference for even the most advanced workers in the field.

Dr. Helstrom's book pursues a comfortable middle course, going into the various facets of statistical detection theory more thoroughly than can be done within the broader approach taken by Davenport and Root, yet stopping short of being encyclopedic. Despite the absence of problems, a deficiency that can readily be made up by drawing from the adequate sets provided by Davenport and Root, and Middleton, this book seems, as its author claims, to be well suited to first-year graduate study. If a term were devoted to the text, plus problems, the student would at the finish be fully acquainted with detection theory, and moreover, would be versed in many of the mathematical techniques that are used in noise and signal analysis.

One of the most attractive features about this book is that it is nicely self-contained. Familiarity with circuit theory is not assumed, nor even knowledge of the theory of probability — essentials of both are given in the first chapter and an appendix, respectively. There is also an appendix on Fourier and Laplace transform theory, but it would be best that the reader already have a working knowledge of these methods. Another peripheral topic is a short description of the physical mechanisms by which noise is generated. While hardly essential to the main theme, this excursion again indicates the thorough-going approach taken by the author. Not only is there a satisfying unity as a whole, but each chapter is to some degree automomous, so that there is a minimum of "hopping about." This convenience is achieved, of course, by mild repetition; one soon greets as an old friend the decision prescription that the likelihood ratio Λ shall be compared with a threshold Λ_0.

While thorough where it can aid easy understanding, Dr. Helstrom's treatment steers well clear of fine points of mathematical rigor, such as the conditions under which certain integrals or infinite series exist. The mathematically formal method of derivation that he has adopted enables the correct results to be obtained with a minimum of handwaving, and complements the clear, simple statement of the text. The author seldom misses an opportunity to reinforce the mathematics with physical argument or intuitive logic. For example, he derives the test for distinguishing between a pair of simple hypotheses according to the Bayes average-risk criterion, and then shows that the decision rule agrees with the sensible notion of making each decision in such a way that the risk that is conditional on the observation is always the least possible. He also takes care after the derivation of each test to describe how it can be carried out on the observed data, which is usually a time series or waveform, by electronic devices such as filters, multipliers, rectifiers and integrators. This adds a happy "real life" flavor.

The first two chapters of the book proceed from elementary signal and circuit theory through the use of probability theory in characterizing random signals and noise. The convenience of using complex-variable notation when dealing with signals and filters of narrow bandwidth is demonstrated. In introducing the autocovariance and the power spectrum the author includes a careful discussion of the difficulty of measuring the latter. The groundwork is completed by a section on the elegant properties of gaussian noise processes which enable the forthcoming hyopthesis tests to take quite explicit form.

Chapter III formulates the general philosophy of testing to distinguish between two exhaustive and mutually exclusive simple hypotheses. It is shown that the central statistic in all such tests is the likelihood ratio, which is the ratio of the probability density function of the observation under the first hypothesis to that under the second. The observed data may be a single variable or a sequence of variables. The Bayes test is established for the situation where the *a priori* probability of one of the hypotheses is known and the costs of making decision errors are also known. The more conservative minimax test is then introduced to deal with situations where only the error costs are known. When neither *a priori* probabilities nor costs are known, as is often the case in radar, the original Neyman-Pearson test is appropriate, where the probability of one of the two types of error is held fixed while that of the other is minimized. Brief mention is made of a fourth type of test, the sequential one originated

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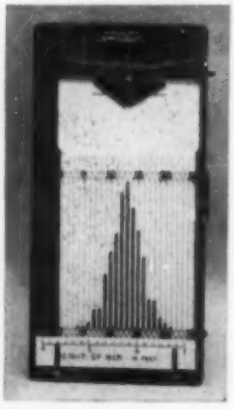

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by Wald, in which the average length of the observation enters, with the error probabilities, into the cost of the test. This topic needs more attention and exposition, since among other applications, it promises significant economies in the design and operation of radar systems.

In the fourth chapter, hypothesis testing is applied to the engineering problem of determining whether or not the observed data contain, in addition to obscuring gaussian noise, a signal of known waveform. The optimum detector is found to process the observation with a linear filter, and the signal detectability (a function of the error probabilities) is assessed for this detector. The derivations employ a simple sampling-point analysis when the noise has a "white," uniform spectrum, and turn to the alternate, more elegant eigenfunction methods of Karhunen and Loéve when the noise is "colored." The author uses the latter analysis as an opportunity to familiarize the reader with the important theory of linear integral equations, formally establishing the essential theorems and providing explicit examples of some solutions.

In Chapter V one of the pair of hypotheses is allowed to involve unknown parameters, thereby becoming a "composite" hypothesis. When the parameter statistics, the *a priori* probability of the remaining simple hypothesis, and the error costs are all known, a Bayes test can be derived. When none of these are known, a Neyman-Pearson test can be developed in which the least-favorable probability distribution of parameter values is assumed. This latter attack is applicable to the detection of radar pulses where one or more of the parameters of phase, amplitude and arrival time are unknown; if all three parameters are unknown, however, the use of the least-favorable distribution turns out to be rather unsatisfactory. Chapter VI extends this radar detection analysis to multiple, rather than single, observations, and in both chapters the signal detectabilities are evaluated for the detectors that are derived.

The next two chapters deal with the theory of parameter estimation, where in effect there can be a continuous infinitude of hypotheses instead of just two. The earlier Bayes and minimax detection tests are directly extended to analogous estimation procedures, and the notions of sufficiency, efficiency, and consistency of estimates are set forth. When neither the error costs nor the *a priori* probability distributions of the parameters are well known, maximum-likelihood estimation is proposed, where the parameter values are chosen to make the observed data appear conditionally most likely. Maximum-likelihood estimation is applied to the determination of the phase, amplitude, and arrival time of a radar pulse, and is then extended to the reception of a pulse train, and also to the estimation of doppler frequency. The relation of the theoretical results to conventional radar systems is pointed out, and the variances of the estimates are derived.

Chapter IX returns to the problem studied in Chapter V, where one tries to distinguish between two hypotheses, the first being simple and the second composite. Using maximum likelihood estimation, an alternative hypothesis test is proposed in place of the Bayes, Minimax or Neyman-Pearson tests. In this test, called "maximum likelihood detection," a maximum-likelihood estimate is made of the parameters on the assumption that the composite hypothesis prevails, and the resulting parameter values are analyzed to see whether, with reasonable probability, they could have arisen accidentally under the simple hypothesis. Although generally simpler than the optimum detection schemes, this strategy is shown to be practically as good when reliable decisions are expected, and is often superior to the use of least-favorable probability distributions when the parameter distributions are unknown. Maximum-likelihood detection is applied to radar, where the signals have unknown arrival time and doppler frequency; in working out the error probabilities the as yet unsolved "first passage time," or "zero crossing" problem is encountered, and a reasonable alternative course is followed which involves the false-alarm rate rather than the false-alarm probability.

The material of Chapter X is concerned with the problem of discriminating one radar target from another when they differ in range and range rate. The problem is shown to involve a complex correlation function of the transmitted signal, which the author calls the "resolution parameter," and which is also involved in the variances of the range and frequency estimates for a single target, as studied in Chapter VIII. (This complex correlation function has been called by others the "ambiguity function" or "uncertainty function" — it seems about time for some standardization). When a target is obscured by a background of clutter from extraneous objects as well as by noise, a reasonable detection scheme is found by treating the clutter as though it were equivalent to colored gaussian noise; a wide transmitted bandwidth then turns out to be advantageous.

The final chapter deals with the detection of a stochastic signal — a signal whose waveform is quite unpredictable and involves an infinity of random parameters, rather than just a few such as phase, arrival time, and amplitude. Assuming that the signal as well as the noise is

gaussian, a general form for the optimum detector is found by using Karhunen - Loéve eigenfunction methods. The error probabilities involve rather complicated mathematical expressions (the author's original work) which are similar to those encountered in studies of the filtered output of a quadratic detector. Under certain circumstances (which probably do not exist where natural noise is encountered) it is possible to decide between two hypotheses with vanishingly small probability of error, even when the observation interval is extremely small — this provocative topic of "singular" detection is discussed briefly. At the last, there is a review which, taken with the introduction to Chapter III, provides a succinct summary of the aims and methods of statistical detection theory.

This reader finds it difficult to find fault with such an excellent, scholarly work. There are of course the usual trivia of minor misprints, but remarkably few for a first printing. It would perhaps have been helpful to give explicit reference to the important theorem on p. 50 that linear systems propagate gaussian statistics, and to the Lagrangian multiplier technique mentioned on p. 75. The definition of statistical independence given on p. 29 is needlessly restricted to a stationary process, and the semi-colon notation used for both joint and conditional probabilities on pp. 187-189 is rather confusing, particularly in view of the comma and vertical bar used elsewhere. On p. 187 it was not at first apparent to this reader that the "joint" probability density function $p(x;\alpha)$ is not joint with α. On p. 308 the impulse response of a time-variable filter is not clearly defined.

These are all rather carping criticisms, and the only serious one I have to offer is that the text seems overly oriented toward radar, at the expense of leaving out some useful applications of detection theory to communications. For example, it would have been worth while to consider the situation where two composite hypotheses must be distinguished, as in communicating through noisy, random-phase media by other than on-off signaling. Dr. Helstrom has modestly omitted his own significant work on this topic, although it is referred to in a footnote on p. 269, and he has also left out the important extensions that have been made by Turin[3] (moreover, answering the remarks at the top of p. 299, Turin[4] has studied the problem of communicating through a random-delay multipath channel from the standpoint of detection theory). A discussion of transmission waveform optimization in communications, particularly the use of orthogonal or simplex-forming signals, would have been of value and could have served as a bridge to information theory.

The bibliography and index are very well done, except for the notable omission of Kotel'nikov. Quick cross-reference is hindered by the lack of chapter numbers either at the tops of the pages, in the chapter sub-headings, or in the equation numbers.

This book will certainly serve as a standard reference for a number of years to come, and will be very effective in introducing the concepts and applications of statistical detection theory to numerous engineers, physicists and mathematicians.

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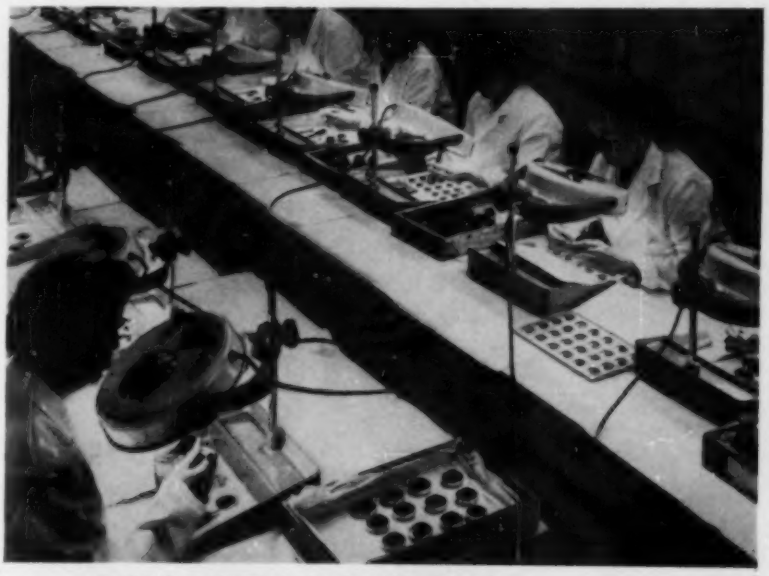

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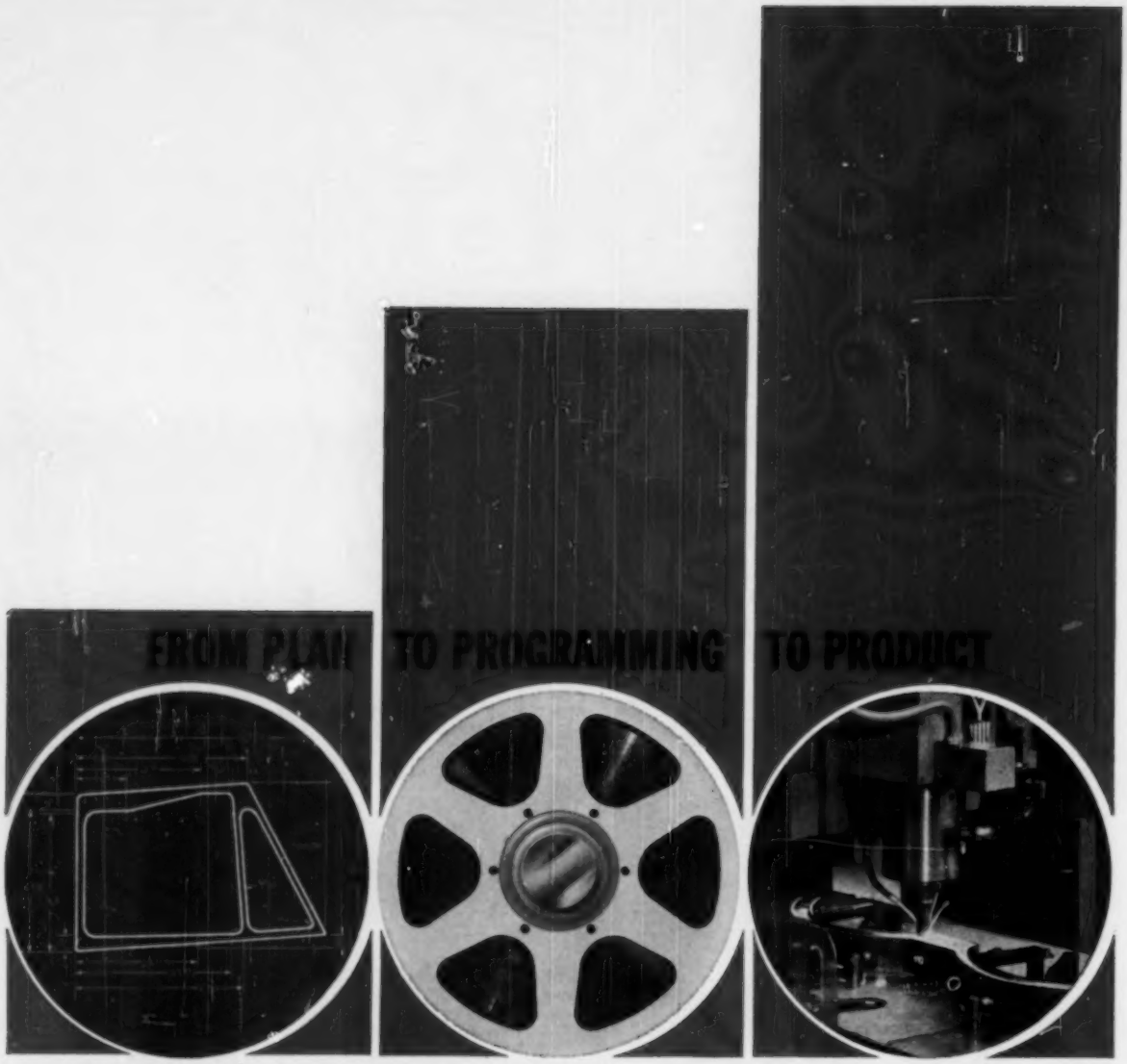

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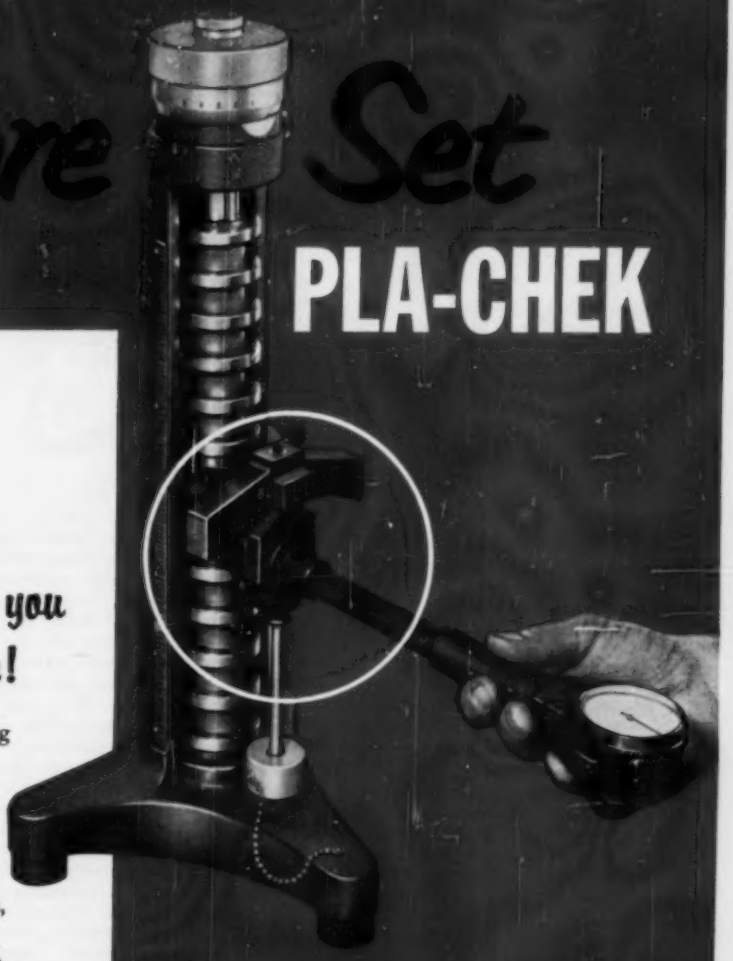

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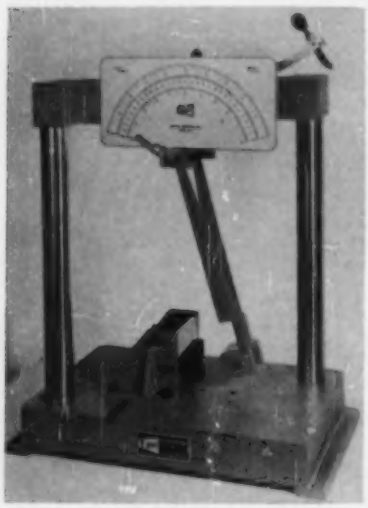

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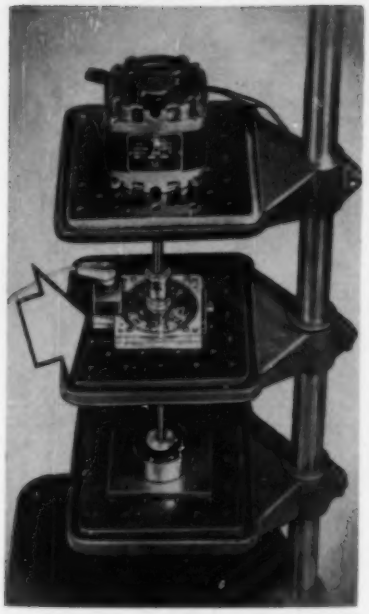

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By S. S. WILKS, *Princeton University*. A systematic, unified presentation of major, recent developments, particularly over the past 25 years. Particular attention is paid to underlying probability theory.

1961. In press

Proceedings of the Second International Conference on Operational Research

Edited by J. BANBURY and J. MAITLAND. Covers methodological aspects, computers and O. R., human factors, production control, inventory control, and applications to industry, government, electric and atomic power, the military, and transport.

1961. In press

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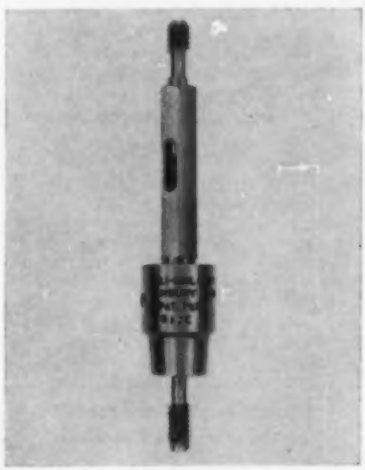
terials such as glass, hard rubber and ceramics can also be inspected. New features include built-in facilities for high-sensitivity, high-resolution contact testing; variable pulse repetition rate; High Speed Flaw Alarm circuit (for positive automatic warning when flaws are detected); built-in recorder output circuits for direct connection to Curtiss-Wright Electrosensitive Recorders; and built-in video delay circuit.

* * *

510 — A new Hastings - Raydist Miniature Vacuum Recorder is only 3⅝ inches wide and 5⅝ inches high, and is suitable for bench, desk or panel mounted installations. Miniaturization of the Hastings Patented Compensated Thermopile Vacuum Gauge circuitry makes possible this self-contained instrument. Ranges are 0-1000 micron Hg and 0-20 mm Hg. Full voltage regulation is incorporated in the circuitry. All gauge tubes are matched and interchangeable, without readjustment or recalibration, and incorporate full temperature compensation. Operation is from 115 volt a.c. 60-cycle line. Chart paper and recorder scales are calibrated directly in absolute pressure units. The calibration is unaffected by exposure to, or changes in, atmospheric pressure. Pressure sensitive chart paper is marked by clamping bar action eliminating messy inks.



509 — A new Unviersal Adjustable Depth Gage Handle, which permits gaging both size and depth of all drilled and tapped holes in one operation, has been announced by Heli-Coil Corp. Depth gaging is achieved by the new adjustable handle with minimum pre-setting. The need for grinding a step on the go-nib for each individual thread size and depth has been eliminated. The go-nib is placed in the adjustable collar end of the handle; the hexagon socket set screw in the collar is loosened; the threaded collar is adjusted to the specified thread depth and securely locked in place by tightening the set screw. Then the go-gage is screwed into the tapped or drilled hole until the collar touches the boss material. The handles are available in four sizes and may be used with American Standard thread gages for measuring standard tapped holes, and with a pin gage for measuring drilled holes, in addition to the full line of "Heli-Coil" thread gages. Prices range from $3.00 to $4.90 each, depending on size and quantity ordered.

* * *

511 — A variety of fixtures for mounting special equipment to aid in precision measurement and checking operations can now be provided on all granite surface plates manufactured by The Herman Stone Company. Included are threaded inserts, adapter holes, tee slots and dove tail slots for holding work or attaching indexing heads, bench centers and similar equipment. Also available are precision graduated steel straight edges to aid in positioning and measurement of work. Fixtures can be located at any point on the surface plates as required. Granite surface plates can also be manufactured with precision edges or sides. This provides a second accurate reference plane, allowing both vertical and lateral gaging of work on the surface plate at the same time. The edges are of particular value in making horizontal measurements for straightness and parallelism. Any edge can be straight within 0.00001 inch every three feet including squared to the top surface within 0.001 inch, squared with adjacent edges within 0.0001 inch each foot, or parallel with tee slots and dove tail slots or opposite edges within 0.001 inch every five feet.

* * *

513 — Master balls for precision checking of hole depth and internal taper, setting and checking comparator gages, radii and helical gear teeth are now available in dimensionally-stable tungsten carbide from Industrial Tectonics, Inc. These balls, guaranteed accurate to ±0.000010 inch on both sphericity and diameter, have a surface finish of one microinch, rms. Their extreme hardness — 89 to 91 Rockwell A — makes them highly resistant to abrasion, wear and accidental impact. In addition, the problem of pitting, rusting and corrosion from handling or humidity are gone forever. ITI Master balls, available in sets and individually, offer many advantages over ordinary gage blocks, and at far less cost. An illustrated brochure (B-41) on solving gaging problems with master balls is available on request.

512 — More precise thickness measurement of sheet materials is now possible. It is achieved by a further refinement to the manual Dead Weight Micrometer. Until now, there has always been the question of reproducible application of the measuring pressure. Spring operated instruments change with temperature and age. The measuring pressure of screw type micrometers is generally not known. With the hand operated Dead Weight Micrometer, the weight is unchanging but the operator can affect the reading by his method of dropping the dead weight load. The new TMI Motorized Dead Weight Precision Micrometer eliminates all these variables. It is not hand operated and the readings are most reproducible and will correlate from operator-to-operator and from plant-to-plant. The new micrometer assures that a dead weight measuring load is always applied in exactly the same way. The cam which lowers the dead weight measuring load loses contact with the load during the dwell period when the measurement is being noted. Therefore, the dead weight exerts pressure on the sheet. The operator has both hands free to handle the sheet and write down the readings. Cycling time for each measurement is five seconds but other speeds can be furnished. Measuring anvils are lapped flat stainless steel with the lower anvil adjustable with three lock screws to obtain exact parallelism of the measuring surfaces. When many measurements are to be made, a considerable savings in time is possible with less operator fatigue and less chance for error. Most important — measurement of compressible sheet materials such as plastics, paper and paperboard can now be made with full confidence that the results are accurate for present purposes and that the data compiled now will be valuable and meaningful in the future.

506—An adjustable Indicating Snap Gage with indicator reading in 50 millionths or finer has been introduced by the Mahr Gage Co. A lever located on the back of the frame permits rapid retraction of the anvil by means of the index finger placing the gage in the correct measuring position. A predetermined adjustable measuring pressure of the anvil aids the final measuring procedure and thus eliminates "feel" of the operator. Setting is made rapidly by turning the knurled ring on the spindle shaft. Gage blocks or plug gages are used for setting. A fine adjustment screw is conveniently located on the indicator housing. Five sizes cover a range of from zero to eight inches. One gaging head can be interchanged in all sizes. Gaging heads reading directly in 50 millionths, 20 millionths and ½ thousandths of an inch are available.

New Literature Available

514 — Automatic determination of chromates is described in a new two-page methodology sheet available from Technicon Controls, Inc. The complete chemical methodology is detailed for the rapid determination of chromates down to parts per million using the Technicon Auto-Analyzer, an electronic analytical instrumentation system, which requires no supervision. A flow diagram of the analytical system is included, together with the actual chart recordings derived.

* * *

515 — A 15-page abridged catalog describes all currently manufactured Tektronix Oscilloscopes and associated electronic equipment. The catalog includes 24 conventional oscilloscopes, six portable oscilloscopes and 12 rack-mount versions in addition to the associated instrumentation.

* * *

516 — Complete information on air gaging is available in the new catalog prepared by the Taft-Peirce Manufacturing Co. The book describes air gaging principles and applications, as well as the equipment available for performing these functions.

* * *

517—"How to Measure and Relate Pipe, Tubing and Hose Sizes" is the title of a new 16-page booklet, recently produced by Aeroquip Corp. The booklet supplies standard methods of measurements, discussing both the similarities and the differences involved in measuring various fittings and fluid-carrying lines in order to arrive at satisfactory fluid line installations.

* * *

518 — A 30-page booklet entitled "Inspection Manual for Hot Dip Galvanized Products" has been published by the American Zinc Institute in conjunction with the American Hot Dip Galvanizers Association. Galvanized products are easily inspected when the proper criteria dictated by the function and the nature of the coating are applied. The purpose of this manual is to establish and explain these criteria.

* * *

519—A new bulletin describing the F-20 transistor tester is now available from Molecular Electronics, Inc. The bulletin highlights the principal advantage of the tester, instantaneous indication of gain-bandwidth product, and in addition, lists other features of the F-20 unit.

* * *

520 — A 28-page catalog covering StereoZoom Microscopes has been published by Bausch & Lomb Optical Co. The catalog illustrates the many types and uses of Stereo Zoom microscopes and accessories.

* * *

521—An idea book picturing many ingenious gage modifications is available on request from Boice Gages, Inc. The 84-page booklet entitled "Ideas" shows how standard Boice components can be incorporated in special and unusual gaging assemblies.

* * *

522—A 3-page brochure describing the K-44 Magnetic Tape Tensiometer has been published by General Kinetics, Inc. The new instrument handles tape up to one inch wide and will be of particular interest to users of magnetic tape devices.

* * *

523—A new catalog has been released by Associated Research, Inc. Instruments described include high voltage dielectric strength test sets, megohmmeters for measuring insulation resistance, insulating materials and oils testers, power supplies, testers for ground resistance and corrosion control engineering, phase sequence indicators, and portable kilovoltmeters. Unusual instruments are described such as Corona detection and measurement equipment, portable kilovoltmeters, high voltage power supplies, and sphere gap assemblies.

* * *

524 — Jones & Lamson Machine Company has made available a new 60-page book on Jones & Lamson Comparators. Though it contains complete catalog information, one section takes the reader through a step by step illustrated demonstration of how basic measuring is accomplished; other sections of the book provide details on accessories and illustrates over twenty applications, varying from tiny electronic components to large steam turbine blades.

* * *

525 — Micrometrical Manufacturing Company has announced the availability of a new Profilometer Catalog. Catalog 160 describes a complete line of shop equipment for measuring surface roughness.

* * *

526 — Compilation of ASTM Standards on Textile Materials — D-13 is now available. The 1960 edition contains 139 standards of which 24 are new, revised, or have had their status recently changed. Among the new standards are test for neps in wool top, test for imperfection count of textile yarns, method of testing elastic fabrics, and test for colorfastness to commercial laundering and to domestic washing of tufted rugs and carpets. Topics covered in the compilation include wool textiles, man-made fiber textiles, glass textiles, cotton textiles, bast and leaf fiber textiles and kraft yarns, tire cord, carpets, hosiery, and nonwoven fabrics. In addition, the volume contains standards on: terms and definitions, conditioning; sampling, qualitative and quantitative analysis, and resistance to insects and micro-organisms. Fibers, fabrics, yarns, threads and cordage are also covered. Fourteen appendices and additional related material are included in this volume.

* * *

527 — 1960 Research Highlights of the National Bureau of Standards (Annual Report) may now be ordered from your nearest U.S. Department of Commerce Field Office or Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price—65 cents each. Additional publications are Circular 460 (1901-1947) $1.25, and Supplement to Circular 460 (1947-1957) $1.50. Make all checks payable to Superintendent of Documents. Foreign postage, one-fourth additional.

* * *

528 — Supplement 1 to the electronic equipment reliability handbook used by the Air Force's ground equipment research and development center at Rome, N.Y., is now available through the Office of Technical Services, Business and Defense Services Administration, U.S. Department of Commerce, Washington 25, D.C.

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section briefs

AKRON-CANTON . . . Feb. 16, "Sampling Techniques for Management" by Professor Richard Cyert . . . Topic covered various accounting and inventory problems and the necessity for the statistical rather than the old fashioned intuitive approach . . .

May 19, Ladies' Night, Firestone Country Club . . . The program committee has scheduled a first class speaker . . .

H. P. Pierce

ALBANY . . . Feb. 2, we were indeed fortunate to have E. V. Grumman, chief engineer, Bullard Co., present "High Quality Through Quality in People" . . .

Mr. Grumman presented this fine talk last year at the ASQC Annual Convention in San Francisco, Calif. He showed slides and discussed customer and vendor motivation on quality. He outlined a technique to determine "where you stand today and how you can cope with tomorrow's problems"

At the Bullard Co., he organized the automatic control division. The studies which he has developed have gained widespread recognition.

At the same meeting, the Marchant Company demonstrated two of the newest models — the "Transflo" and the "Deci-Magic."

May 4, plant tour, Silicone Products Department, General Electric Co., Waterford, N.Y., at 4:30 p.m., followed by dinner . . . Speaker for the evening will be Leonard A. Seder, Leonard A. Seder and Associates, Malden, Mass. . . . The topic, "Prevent Defects Before They Occur — New Design Control" . . .

M. P. Flanagan

ALLENTOWN-BETHLEHEM . . . Feb. 8, Hotel Traylor, Allentown, Pa., "Vendor-Consumer Relations" by A. P. Stergion of the Corning Glass Works, Corning, N.Y. . . .

Mr. Stergion told us the basic reasons for good vendor-consumer relations and how his company goes about establishing and improving them through use of various of the statistical tools available. As Mr. Stergion puts it, this is strictly a two-way street, a give-and-take proposition, if you will. His company assists supplier companies to establish and maintain QC programs.

The meeting was preceded by a short discussion on short-run QC led by our chairman, Dick Zwickl, who did a commendable job pinch-hitting for Miss Bonnie Small, Western Electric Co., Allentown, Pa.

David F. Roberts

BATTLE CREEK-KALAMAZOO . . . Feb. 16, Curtiss Williams, General Electric Co., Cincinnati, Ohio, presented a well received talk on "Outgoing Control of Quality and Customer Complaints" at our meeting at Michigan State University, Lansing, Mich. . . .

May 13, the section, in cooperation with Western Michigan University, is presenting its first All Day QC Forum . . .

The program will feature excellent speakers representing many facets of industry and government. It will consist of two parts — Engineering and Research and Administration and Supervision. The combined theme will be "Toward Total Quality Control." It will be held at the Western Michigan University Center, Kalamazoo, Michigan.

May 18, Ladies' Night, Anchor Inn, Gull Lake . . . This promises to be an interesting evening . . . The speaker, Knight D. McKesson, public relations, Lansing, Mich., will present "Pitfalls of Mortgage and Marriage."

Peter F. Koets

BUFFALO . . . Feb. 27, Red Lobster Banquet Room, Tonawanda, N.Y., "Better Answers With Less Work" by Dr. W. J. Youden, National Bureau of Standards . . .

Dr. Youden is internationally prominent in statistics, especially in biometry and experiment design. He received his B.S. degree from the University of Rochester and his M.A. and Ph.D. from Columbia University.

He was a chemist at the Boyce-Thompson Institute from 1924 to 1948, was an operations analyst for the Air Force during the war, and is currently a consultant to the Mathematics Division of the National Bureau of Standards.

Among his many honors are Fellowships in the ASA, IMS and ISI. He has been a Rockefeller Fellow and has been awarded the United States Medal of Freedom.

Unless experimental design does lead to "better answers with less work" it is not going to help the engineer and scientist. Classical experimental design was directed to the particular problems of the agricultural experimenter. Much more than a switching of norms was required to extend experimental design techniques to laboratory and engineering experimentation.

New experimental design techniques suited to the different and more complex problems are needed and are being devised.

Dr. Irving Gordon

CENTRAL ARKANSAS . . . Jan. 26, the initial meeting of this new section was held at the Arkansas Power and Light Co., West Ninth and Louisiana Streets . . . Our guest speaker was Glen E. Owens, QC coordinator, Convair Division, General Dynamics Corp., Fort Worth, Texas . . .

Section officers are chairman — Cecil A. Haney, Jr., U.S. Time Corp., Little Rock Arkansas; vice chairman — Dewey A. Lane, Westinghouse Corp., Little Rock, Ark.; secretary — Robert V. Anders, A R & T Electronics, Inc., Little Rock, Ark., and treasurer — Dennis Duran, Chicopee Manufacturing Co., North Little Rock, Ark.

Cecil A. Haney, Jr.

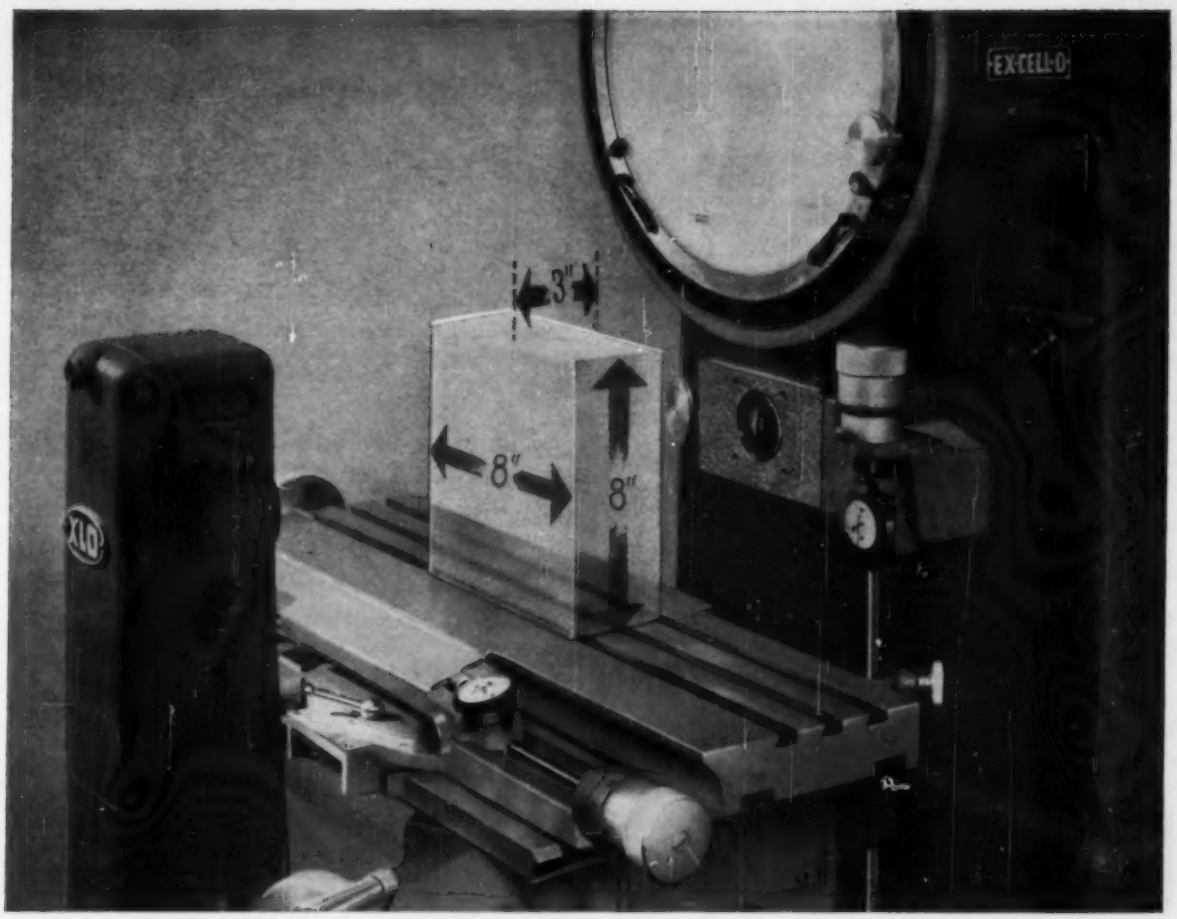
CHARLESTON . . . Feb. 16, C. M. Drummond, mathematics and statistics consultant, E. I. Du Pont de Nemours & Co., Inc., Wilmington, Dela., presented "Multivariate Analysis" in which he defined "open" and "closed" systems and illustrated how multivariate analysis could be used to obtain closure . . . Once this has been accomplished, the designed experiments and regression analysis approach may be used to optimise a given system . . .

F. T. Simon

J. P. Luby

The Dallas-Fort Worth section and the society wishes to extend its heartfelt sympathy to the family of J. P. Luby, Dallas, Texas, on his death Feb. 10.

Mr. Luby was assistant quality control manager for Chance Vought Aircraft, Inc. He has been a member of ASQC for several years.



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CHICAGO . . . May 17, the section's Second Annual "Joe Lisy Award" dinner meeting will be held at the Furniture Club of America, 666 N. Lake Shore Drive, with the social hour starting at 6 p.m. . . .

Guest speaker will be? Honestly, I don't know — the nominating committee hasn't revealed who will be the recipient of the "Joe Lisy Award," but whoever he or she is, you can bet the topic will provide good listening.

This much I do know — that certificates will be awarded to those who completed the advanced course in statistical principles, jointly conducted by Drs. Marjorie Sutherland and Mae Goodwin Tarver.

Chances are the weather will be fine, so circle the date and remind your friends to contact Miss Ann Livingstone of Zenith Radio, BE 7-7500, Ext. 425, for advance dinner reservations. Cost of the dinner is $4.

John Dittrich

CLEVELAND . . . Feb. 3, in his presentation on "Value Analysis" Dr. C. C. Van Vechten, Thompson Ramo Wooldridge, explained the workings of a value analysis engineer and gave many examples of the savings which value analysis has obtained in many companies . . .

Feb. 21, J. T. Oesterling, section chairman, and John F. Occarione, district representative, met with a group from Ashtabula, Ohio, to discuss the formation of a new subsection.

R. F. Perrine, Reliance Electric and Engineering Co., is spearheading the group. There were 27 present for the presentation, and it is hoped that a full program of meetings will be planned for this coming year.

Howard O. Schmidt

COLUMBUS . . . Feb. 15, A. L. Phillips, assistant superintendent, inspection, Hawthorne Works, Western Elec-

(Please turn to page 64)

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WHY NOT SEND YOURS IN TODAY?

Automotive Division luncheon during the Fourth National Conference on "Automotive Reliability" Feb. 11, at the Rackham Memorial Bldg., Detroit, Mich.

Automotive Division and Greater Detroit Section Sponsors QC Conference

The Fourth Annual Conference sponsored by the Automotive Division and Greater Detroit section, ASQC, was a great success. It was held Saturday, Feb. 11, at the Rackham Memorial Bldg., Detroit, Mich.

The theme "Automotive Reliability" was defined as "present quality control, its statistical applications and techniques, with the element of 'time' added."

More appropriately, product reliability is the system of mathematical analysis and the probability of successful operation by a unit which is manufactured to design specifications, used in the recommended manner in the correct environment for a predicted period of time.

Two hundred forty-two members and guests enjoyed the most interesting discussions and presentations of principles analyzing manufacturing processes and field data to determine "How Quality Control can help improve reliability of consumer goods, i.e., the automotive industry."

Under the leadership of Brooke Westover, Chrysler Corp., the program general chairman, the committee was extremely proud to present this well rounded conference with the 13 conference leaders who brought with them a varied background and an aggregate of 195 years of both industrial and teaching experience in this field.

Today the goal of "Reliability" is not a pipe dream; it is a prime requisite. It can be achieved only by logical and well-conceived design effort, effective application of operational data to product improvement, and the awareness of the danger of degradation throughout production and operational usage. All of us in industry share a responsibility in fulfillment of this objective, and it can be rewarding if industry with Quality Control faces the problem squarely and realistically.

Automotive Division Officers are chairman—John J. Ryan, Pontiac Motor Division, GMC; chairman-elect—Dale A. Cue, Hoover Ball and Bearing; treasurer—Judson Jarvis, Wolverine Tube Division, Calumet and Hecla, Inc., and secretary—Louis Haydu, Ford Motor Co.

National Conference Committee members were general chairman—Brooke Westover, Chrysler Corp.; program—David Dillingham, Detroit Transmission Division, GMC; transactions—Edward J. Diggs, Chevrolet Motor Division, GMC; arrangements—Max Clarkson, Chrysler Corp.; publicity—John Birecki, Chrysler Corp.; registration—Steve Adams, Wolverine Tube Division, Calumet and Hecla, Inc., and promotion and mailing—Howell Burke, Chrysler Corp.

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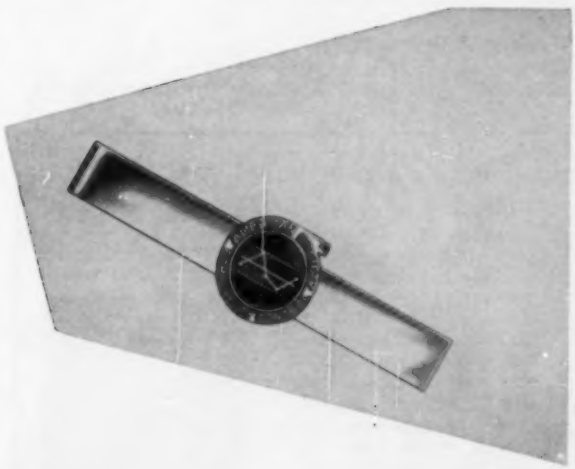
The bar is silver for Member grade and 10K gold for Senior and Fellow grade. It comes in either the horizontal bar or chain type. Sections wishing to use these for awards to past chairmen or other members will find them especially suitable. The surface of the bar, which is shown here slightly larger than actual size, is plain so that your message or citation can be engraved on it.

Handsomely styled lapel buttons are available for each grade of membership. The blue Society seal is outlined in white enamel for Associate grade, in Siltone for Member grade, 10K Goldtone for Senior grade and 10K gold with a genuine sapphire gem for Fellow grade.



Your office or den is the place to display an 8 x 10 membership certificate suitable for framing with your name creatively inscribed. Your professional affiliation increases your stature with company and business associates. Let them know you belong to ASQC. Please allow at least eight weeks for delivery.

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tric Co., Chicago, Ill., gave a very interesting presentation on QC Methods and Charts . . .

May 17, 8 p.m., R. C. Draudt, chief QC analyst, Columbus Division, North American Aviation, Inc., will speak on "Reliability Evaluation of a Weapon System".

Mr. Draudt has been associated with aircraft operation and manufacture for 20 years. As chairman of the NAA Columbus Reliability Committee, he has been actively engaged in the organization and development of the Division's reliability program.

To express reliability "quantitatively," it is essential that mean time between failures be accurately known. Mr. Draudt will present the elapsed time meter program which has been used to measure and/or evaluate achieved electronic system reliability during the A3J weapon system development.

G. E. Arris

CORNING-ELMIRA . . . Feb. 14, Hickory House, Horseheads, N.Y., Leon Peao, Pressware Plant, Corning Glass Works, Corning, N.Y., presented "Why Quality Control?"

The speaker at the April meeting will be Mayor Edward Moores of Elmira, N.Y.

Richard Gibson

DALLAS-FORT WORTH . . . Bryant E. Justice, inspection superintendent, Convair, Fort Worth, Texas, gave a very interesting talk on "Unity in Quality Control." Mr. Justice is the first local speaker to make the tour of the Texas sections, and he was enthusiastically received.

During the business portion of the meeting, the nominating committee presented its recommended slate of officers for the 1961-62 fiscal year. No additional nominations were made from the floor, and the secretary was instructed to prepare and mail ballots to all members.

Roger W. Anderson, section chairman, will speak to all four Texas sections during the week ending May 20. He will speak to the Dallas-Fort Worth section on May 18. The title of his talk will be "Three Applications of Analytical Techniques and Experimental Design."

R. R. Massegee

DAYTON . . . Jan. 12, Dr. J. N. Berretoni, Western Reserve University, presented "Simplified Approach to Analysis of Variance" . . . The meeting was held in the educational conference room of Frigidaire Plant 1, Dayton, Ohio . . . Recipients of door prizes were R. M. Durrill, a guest from California, and R. McDaniel, National Cash Register Co., Dayton, Ohio, and James Tunney . . .

May 4, J. Y. McClure, ASQC president, will be our guest speaker at the Van Cleve Hotel, Dayton, Ohio . . .

Harleigh F. Diehl

GREATER DETROIT . . . Feb. 11, Automotive Division Conference at the Engineering Society of Detroit . . . More than 200 persons attended the morning and afternoon sessions . . . Theme — reliability . . .

Brooke Westover, Chrysler Corp., was general chairman of the conference.

John J. Ryan, Pontiac Motor Division, Division chairman, spoke at lunch on the need for new faces among volunteers.

"There's a job for everyone," he said, "even if you are the kind who likes nothing better than to sit at home and read by the fire."

Speakers included Henry C. Bujack, Vickers, Inc.; John H. K. Kao, Cornell University; Dorian Shainin, Rath & Strong; Lloyd M. Steward, AC Sparkplug Division; Harmon Bayer, Bayer & Kobert Associates; William A. MacCrehan, Bendix Corp.; George A. Henderson, Martin Co.; Howard I. Dwyer, Bendix Corp.; and A. M. Carey, Martin Co.

Frances D. Huntington

EVANSVILLE-OWENSBORO . . . Feb. 21, discussion on Personnel Development highlighted with case histories to illustrate the methods used in the development program . . . Our speaker — A. Siebers, personnel manager, Mead Johnson . . .

May 13, Ladies' Night . . . Our speaker — W. Greer, who has made a specialty of analyzing personality through handwriting . . . Mr. Greer has a reputation for keeping his audience entertained with revelations of personality traits, which often is amusing . . . With the wives present, analysis of some of the analysts we know will be interesting to hear . . .

Wane E. VerWayne

HAMILTON-MIDDLETOWN . . . May 3, for this final meeting of our 1960-61 season, our speaker, Oscar A. Hoffman, Champion Paper & Fibre, Hamilton, Ohio, will describe "Some Aspects of Operations Research" . . . This is one of the newer techniques in the analysis of business problems, and serves as a fitting close to our season . . .

Mr. Hoffman has had considerable experience in operations research, having been manager of operations research for American Machine and Foundry; operational analyst, MIT, and director of operations research group, Turkish General Staff. He has specialized in chemistry at Drew, Syracuse and Stanford Universities, and holds a Doctorate from Stanford.

Those of us who are unfamiliar with the meaning of operations research, the techniques employed, and the

Arthur L. Phillips

Arthur L. Phillips, 54, died Feb. 18, following an operation in a La Grange, Ill., hospital.

At his death, he was an assistant superintendent in Step-by-Step inspection at Western Electric's Hawthorne Works in Chicago. Western Electric is the manufacturing and supply unit for the Bell Telephone System.

Mr. Phillips

Mr. Phillips was well known throughout the Bell Telephone System in the field of quality control. He was active for many years in the Lincoln, Nebr., section, ASQC. In February of this year he was the featured speaker of the Columbus, Ohio, section. In May 1960, he gave the keynote address at the Bell System Interworks Quality Control Conference, Allentown, Pa.

A large part of the success of the Lincoln QC program as well as the progress of a similar program in the Hawthorne Step-by-Step Shops resulted from his tireless efforts in these plants.

Upon graduation from Ohio State University with a B.S. degree in Engineering, Mr. Phillips joined the Ohio Bell Telephone Company as a student engineer. Later he joined Western Electric at Hawthorne as an engineer. He was promoted to supervisory rank in 1946 and was transferred to Western Electric's Lincoln, Nebr., Shops. He returned to Hawthorne in 1955 upon promotion to the position he held at the time of his death.

Surviving are his widow, Evelyn; a son James, who is a supervisor at the Sandia Corporation, Albuquerque, N.M.; a daughter, Marcia, a student at Bowling Green University; his parents, Mr. and Mrs. Jay Phillips; a sister, Mrs. John Huebner; a brother, Byron Phillips; and two grandchildren.

Burial was in the cemetery of his hometown, Tontogany, Ohio.

relationship between our work and this new field will especially want to attend this meeting.

Mar. 1, two door prizes were given as they were at the January 1961 meeting . . . At the March meeting, the prizes were a travel kit and a manicure set . . .

Lon Ely

HAMILTON . . . Feb. 16, J. B. Pringle, staff engineer, Bell Telephone Co., Montreal, Canada, spoke on "Quality Control in Telephone Transmission" . . .

May 11, we will be conducted on a plant tour of the Harding Carpet Co., Brantford, Ontario . . .

O. W. Holland

HARRISBURG . . . Feb. 1, panel discussion on selling QC to management . . . Due to the inclement weather we have been experiencing in the eastern section of the state and illness, several of the panelists were unable to be present . . . Harold Reehling, section program chairman, acted as moderator . . . Harold Sheaffer, QC manager, Armstrong Cork Co., and Otto Kral, Minnesota Mining and Manufacturing Co., were panelists . . .

Officer nominations for the new season are chairman — H. A. Gross, RCA, Lancaster, Pa.; vice chairman — O. Fox, Borg-Warner, York, Pa.; secretary — J. T. Fasnacht, Jr., Hamilton Watch Co., Lancaster, Pa., and treasurer — R. Lehman, Carlisle Tire & Rubber Co., Carlisle, Pa.

June 7, annual picnic and installation of officers . . . Should be well attended as there will be plenty of food and refreshments as well as games and cards . . .

Ann Englehart

HARRISBURG — READING SUBSECTION . . . The subsection is nearing the completion of a very successful first year under the leadership of chairman Jim Caton. Marty Wohlbruck, our program chairman, was successful in arranging a varied and interesting program. Bill Ziegler, our membership chairman, is to be commended in raising our membership from 28 to 75.

We look forward to May 2 when the last speaker of this year, Miss Bonnie Small, Western Electric Co., Allentown, Pa., will discuss "The Advantages of Statistical QC." Those of us who know Bonnie are confident that her talk will be the highlight of a successful year.

The following men have been elected as the officers for the new 1961-62 term: Wes Sawyer, chairman; Earl D. Wiest, vice chairman, Marino Ruggere, secretary, and Jack Holub, treasurer.

J. P. Napolitano

HARTFORD . . . June 9, Nutmegger House, Newington, Conn., Management Night, "Between Ether and Earth in Quality Control" by Dorian Shainin, Rath & Strong . . . Certificates will be given to local managements in appreciation for the contributions of time and effort to the Hartford section by members of their organizations.

In retrospect, it can be said that this has been an extremely successful and profitable year for the Hartford section. Section membership is at an all-time high. Education programs attracted 150 persons. Plans for the New England Conference in Hartford are being initiated.

L. Sespaniak

KANSAS CITY . . . Feb. 16, the section was treated to a comparison of the popular notions of reliability with the latest techniques needed in this space and missile age by J. M. Wiesen, head of the statistics and components evaluation division, Sandia Corp., Albuquerque, New Mexico.

H. Afton Taylor

KANKAKEE-JOLIET . . . Feb. 7, fried chicken and roast beef at D'Amico's Restaurant in Joliet, Ill. . . . Robert Banzhaf, Ordnance Ammunition Command, Joliet Arsenal, spoke on "Life Testing" . . .

The presentation covered fatigue testing and service life of items subject to vibration or wear and electronic

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items. The techniques have been applied to such products as light bulbs, electronic tubes, relays and switches.

May 2, panel discussion and election of officers at Kankakee — the last meeting of the season . . .

John E. Rauworth

LEXINGTON . . . Feb. 16, Ben H. Carpenter, experimental design group, Union Carbide Chemical Co., presented an illuminating demonstration of the techniques and advantages in the use of Evolutionary Operations for process improvement . . . His straightforward presentation familiarized our members with the broad field of application for this widely acclaimed technique. We recommend him highly to other sections.

James C. Graff

LIMA . . . Feb. 14, Valentine's Day, found the section holding their monthly meeting at Milano's Club, Lima, Ohio . . . The annual Ladies' Night dinner, short business meeting, and dance to "Karl Beach's Orchestra" were the main events of the evening for the 55 couples in attendance . . .

Mrs. Clair Zimmerman, wife of the late Clair Zimmerman, was presented a gavel in token of her husband's outstanding work with the Lima section as section chairman.

Mr. and Mrs. Keith Lewis were in attendance . . . Mr. Lewis, District representative, presented Stephen J. Kadar, Ford Motor Co., with the "Master Section Award," and James Demetriou, Westinghouse Corp., with a "Senior Member Pin."

E. K. Anderson

LOS ANGELES . . . The Second Annual Reliability Symposium was a complete success with more than 600 scientists, engineers, educators and administrators from across the nation.

The one day conference included many new ideas, such as — bring the Engineering Department of UCLA as a co-sponsor; a "Summit Panel" which included all of

Pictured at a Reliability Symposium sponsored by the Los Angeles section were Dr. R. M. Ashley, Autonetics; John Riordon, Department of Defense; John Young, North American Aviation; Dr. W. E. Cox, Northrup Aircraft Corp., and Grant Ireson, Stanford University

the moderators and speakers at the Symposium on a single panel with W. Grant Ireson, head of the department of industrial engineering, Stanford University, and a complete participation by industry, government, military and education.

May 23, the Garrett Corporation will present a panel showing the special problems involved in solving "Small Business Sub-contracting in a Multi-Product Plant" . . .

The guest speaker, Herb Bjornberg, purchasing manager, Garrett Corp., will speak on "Customer-Vendor Relationship as it Relates to Quality Control."

Spotlight speaker will be C. N. Monson, vice president, Garrett Corp.

The Symposium received a 25 inch column in the 563 338 circulation Los Angeles *Times*, giving the section a new high in Symposium coverage.

Steve Kozich

LOS ANGELES—VALLEY SUBSECTION . . . Feb. 15, a meeting was held to discuss the plans and objectives of the subsection . . .

The Valley subsection will conduct dinner meetings every third meeting and will adopt a new commercial approach on programs directed toward the interest of the commercial product manufacturer.

MEMPHIS . . . Feb. 14, Firestone Tire and Rubber Company played host to the section. William I. (Bill) Martin, consultant for the mathematical group at the Research Center, Koppers Co., Inc., Virona, Pa., and chairman of the Pittsburgh section, ASQC, was the guest speaker. He outlined a planned, eight-step approach for conducting experimental work in his presentation, "Planning Ahead." Refreshments were served at the conclusion of the meeting.

May 15, Richard A. Freund, Eastman Kodak Co., Rochester, N.Y., will present "A Reconsideration of the Variables Control Chart, with Special Reference to the Chemical Industries." All members are urged to attend and bring a guest.

Lee Dickerson

MID-HUDSON . . . Feb. 7, Hotel DiPrima, Highland, N.Y. . . Dr. Charles L. Hughes, manager of management education, IBM, Poughkeepsie, N.Y., was guest speaker and analyst for the workshop program . . .

Dr. Hughes is a graduate of Southern Methodist University and received his doctorate from the University of Houston, Texas. Dr. Hughes' subject was "Solving Quality Control Techniques."

The program consisted of member and guest participation through a game procedure.

He demonstrated the variation in efficiency of different groups to properly organize to solve a problem.

The meeting was well attended.

E. L. Leadbitter

MINNESOTA . . . Feb. 14, Tenth Annual Clinic at the Hotel Lowry, Minneapolis, Minn. . . . 100 registrants representing 25 companies from nine cities in Minnesota and South Dakota heard local and national experts

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from six states and Washington, D.C., in a three Division All Day Clinic on management, organization and techniques . . .

Management sessions included a sales manager, chief engineer, and corporate manager look at quality control. Reliability, QC, and a program manager's concept covered the organization sessions.

Techniques in training for reliability, work sampling to aid quality improvement, and practical life testing were also offered.

Our luncheon speaker's topic, "The Legal Aspects of Quality," was a new and interesting concept.

A final panel with a movie on PERT and a review of the day's sessions completed a clinic at which everyone found help to a better understanding of new concepts, the need for closer organization, and what management wants from quality control.

Congratulations to Vida Grace Hildyard and her committee for a very successful clinic.

Violet M. Rice

MONTREAL . . . Feb. 8, a very successful plant tour and talk by Doug. Guthrie was given at the Dominion Rubber Company to a large group of 37 members and guests . . . The topic — "The Human Element in Statistical Quality Control" . . .

Colorful control charts and product material made this an especially interesting plant tour.

Our original meeting on May 10 has been exchanged for A. B. Oxley's talk on "The Mechanics of Reliability."

Mr. Oxley is the reliability coordinator at Canadair and is active in the reliability field with General Dynamics. Before working for Canadair, he was chief engineer for RCA Victor Ltd., Montreal. He is a Fellow of the Institute of Radio Engineers and a past chairman of the Montreal IRE section.

T. F. Waterston

MUNCIE . . . Feb. 16, Pine Shelf Room, Ball State Teachers' College Student Center — dinner and business meeting — our guest speaker, H. O. Hehner, QC manager, Monsanto Chemical Co., St. Louis, Mo., presented a very interesting and informative talk titled "The Professional 'Habit Maketh No Monk'," which was very well received and led to quite an interesting exchange between our members and Mr. Hehner . . .

Richard Dix, section chairman, appointed an educational committee to begin plans for a QC training course to be presented this fall by our members at Ball State Teachers' College. The committee will consist of Robert Dawson, Warner Gear Division; Robert Sawasky, Muncie Chevrolet, and Ben Johnson, Broderick Co.

May 18, Ladies' Night, dinners, favors, and an entertaining speaker . . . We are sure that this will be a very delightful evening as it has always been in past years. Robert Dawson and G. Grile are heading up the committee for this social event.

C. B. Johnson

GREATER MUSKEGON . . . Feb. 9, Ladies' Night, Black Angus, 44 couples enjoyed a delicious smorgasborg featuring ham, chicken, beef, and a variety of 30 dishes . . . Each of the ladies received a corsage and a gift for Valentine's Day . . .

Guest speaker was Charles Anderson, who gave a 30 minute presentation.

Our May meeting will be a joint meeting at Bill Stern's with all of the groups associated with the Muskegon Manufacturers Association. The date and program are still tentative.

William A. Hume

NORTHEAST TENNESSEE . . . Feb. 14, pre-session clinic, Dr. Paul Wheeler, QC manager, Kingsport Press, spoke on "QC Problems in Printing Industry" . . .

Guest speaker was S. L. Carroll, quality assurance manager, Germanium Products, Texas Instrument Co. Mr. Carroll spoke on "Problems in Determining Instrument Accuracy Where Standards Are and Are Not Available."

He also discussed production problems and the capabilities of various methods of measurement. Statistical techniques useful in solving production problems and suitable examples were discussed.

In attendance were 47 members and 36 guests.

Mike Gomez

OMAHA-LINCOLN . . . Feb. 10, Paul Smith, manager, product design, Goodyear Tire & Rubber Co., Lincoln, Nebr., presented an excellent talk on what standards are, how they are arrived at, what happens without them, and some of the real problems faced in the establishment of International Standards . . .

T. C. Anker

PARKERSBURG . . . Feb. 15, joint meeting with the Chemical Engineering Society in the Petroleum Bldg., Marietta College . . . Our speaker — Dr. Gayle W. McElrath of the University of Minnesota . . . Interesting and informative — his comments on the linking of theoretical and practical aspects of statistics was very enlightening for members and their guests . . .

May 17, "Statistical Cost Control in the Paper Industry" by Dr. C. E. Noble, manager of consumer marketing research for the Kimberly Clark Co. . . . this will be our annual dinner meeting . . . Keith Lewis, District Eight representative, has been invited to attend this meeting . . .

Robert R. Stewart

PENSACOLA-MOBILE . . . Feb. 16, Holiday Inn, Pensacola, Fla. . . . "Quality Depends on Little Things," said Delford B. Tallon, guest speaker . . . "It requires intelligent action by everyone, because quality is everyone's business" . . .

Speaking on "A Quality Control Program Management Can Use," Mr. Tallon presented this broad subject in sufficient detail to enable each of us to evaluate our

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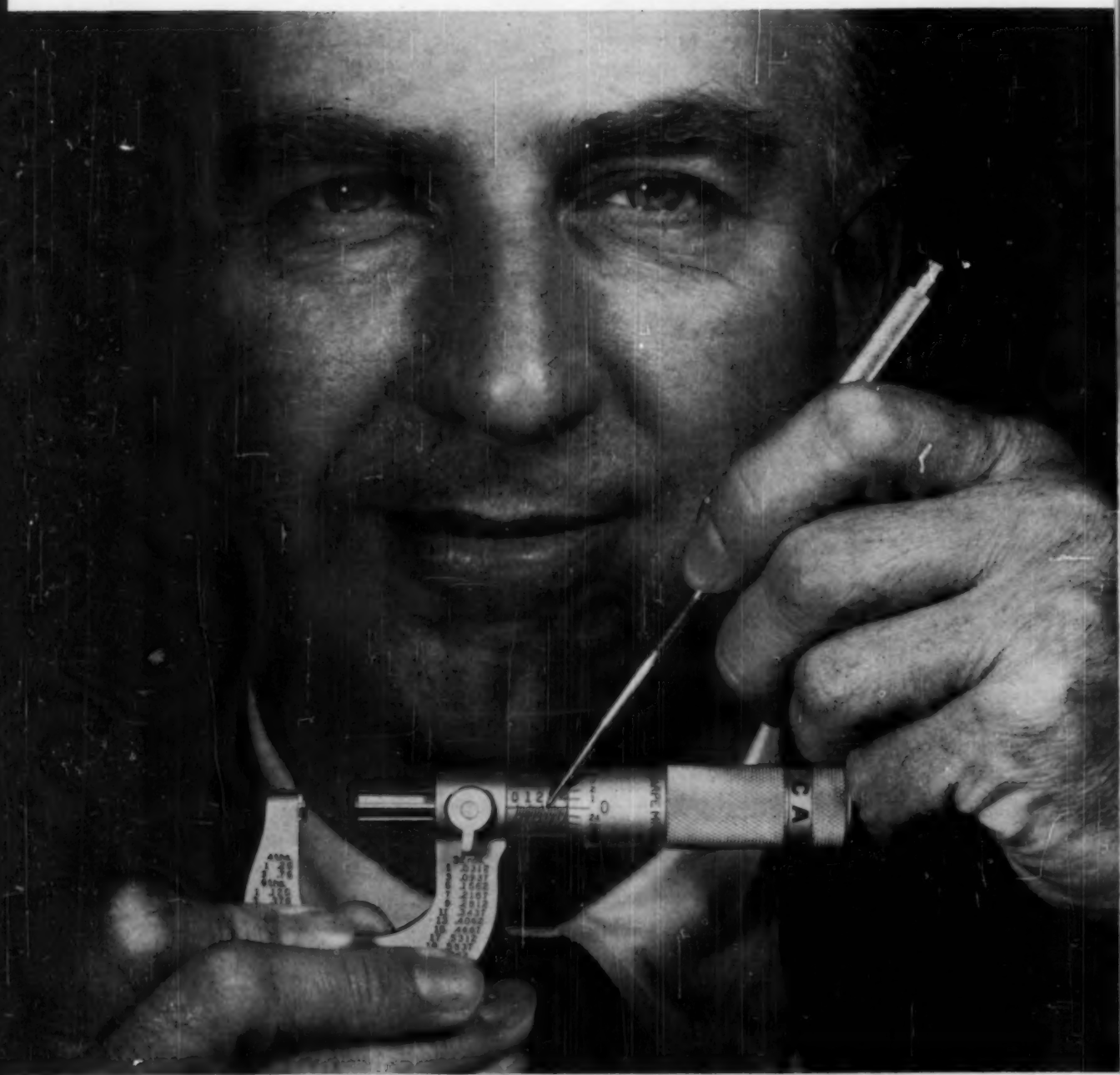

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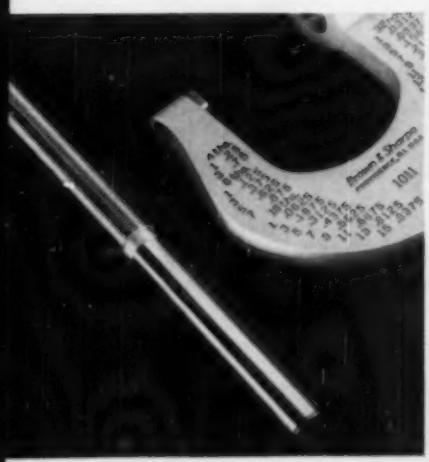

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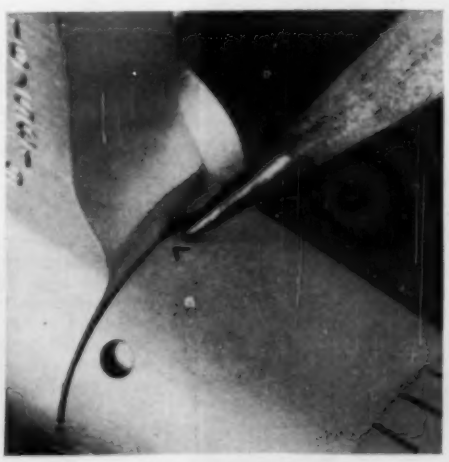

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own quality control efforts. We were happy to have Mr. Tallon with us and we are sure that many of the particulars he discussed will be implemented in this area.

The next meeting of this section will find our members in the company of their wives touring the Maintenance and Laboratory facilities of the Mobile Air Materiel Area, located at Brookley AFB, Ala.

Malcolm A. White, general foreman of the Laboratories, will conduct the tour and will be the after dinner speaker. Subject of his address will be "Quality Control Laboratories."

Walter D. Nencka

PHILADELPHIA . . . Feb. 16, our meeting enlightened us with speakers who covered quality control techniques used in the manufacturing and inspection of steel, pharmaceuticals, and cloth.

Louis Mandich, Lukens Steel Co., was guest speaker and explained the wide range of testing required to meet the regular and specific needs for steel in modern industry. He quoted that the volume of testing had increased 35 percent during the years from 1956-1960. Slides were used to show members the organizational structure and reporting data.

As usual, the after dinner technical sessions were well received. A fine movie in color was supplied by Wyeth Laboratories and shown by vice chairman Tom Moran at Session A. It showed the modern research and production operations at Wyeth with the accent on quality control.

Session B was nicely covered by James Shanahan of MC&TSA, who explained and demonstrated the Point Count Grading System presently used on cotton cloth.

Generally, the system works on the assignment of demerit points charged for visual defects with a numerical limit beyond which cloth lots would be rejected.

Albert G. Dettore

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James Shanahan, Military Clothing and Textile Supply Agency, demonstrates the types of visual defects found in cloth at the technical session of the February meeting of the Philadelphia section. His topic—"Quality Evaluation of Woven Textiles by a Point Count Grading System"

PITTSBURGH . . . Feb. 28, because of many recent successes in the use of multiple regression techniques, the talk by Dr. Kenneth H. Kramer was well received. Examples were shown of the approach to many industrial problems. One example in particular showed the use of this statistical technique in estimating the effects of several compositions and processing variables on the mechanical properties of large alloy steel turbine and generator rotor forgings.

May 16, Ladies' Night . . . Guest speaker — Mrs. Marvis Carroll, General Foods Research Center, Tarrytown, N.Y. . . . Her discussion of new developments and progress in quality control will, we are sure, be of prime interest to our wives . . .

From this discussion, our wives will gain a better understanding of "what do we do at the office all day?"

Chester R. Smith

PITTSFIELD . . . Feb. 15, panel discussion "Optimum Relationships between Quality Control and Purchasing."

We were fortunate in having four panel members that have distinguished themselves in their respective fields -- Maurice E. Blew, Strathmore Paper Co.; Francis G. Jenkins, Sprague Electric Co.; Earl R. Lee, General Electric Co., and Hubert C. Menard, Bausch and Lomb.

Panel moderator Robert Traver asked the panel leading questions and the panel discussed the problems for the first hour. During the second hour, questions were asked from the floor and answered by the panel.

Howard J. Greenslet

PORTLAND . . . May 13, One Day Management Workshop Conference conducted by Dr. J. M. Juran, author, lecturer, and industrial executive . . . This Workshop program will take the place of our usual monthly meeting . . .

In industry, Dr. Juran has served as an engineer, executive officer, and director. He has been employed as a government administrator, university professor, labor relations arbitrator and a consultant to industry; he has written five books and has published more than 100 papers on management subjects. He has lectured in Western Europe, Japan, and Australia, in addition to the United States.

Casey Hoekstra is chairman of the One Day Conference, with Pat Keyes handling registrations; Jim Abell, arrangements; Ray Vanderzanden and George Mickel, publicity.

Our last meeting was a joint meeting with the American Institute of Industrial Engineers. A panel discussion entitled "Quality Control" was moderated by Tony Dresden. Charles Coey and Casey Hoekstra spoke for the AIIE and Henry Blood and Jim Abel spoke for ASQC.

George Mickel

RACINE . . . Feb. 13, the most successful meeting in years at the Hob Nob . . .

C. G. Bauer, corporate director of quality control, Chrysler Corp., presented "The Value of the Quality Audit in Automotive Manufacturing" to an audience of 47, almost 50 percent greater than the section membership.

Mr. Bauer's talk covered the concept of cost, customer satisfaction and competition as well as advantages of quality audits to various staff and line functions. The lengthy and broad participation of the audience during the question-and-answer period gave evidence of the group's appreciation of the speech.

As a part of the program, certificates were awarded to those who had completed a QC Seminar co-sponsored by the Racine section and the vocational and adult school. Guests who participated in the presentation were George Strombeck, coordinator — trade and industry — of the vocational school, and Arnold Jakel, instructor, who is well-known as a QC Consultant and as a most active member of the Milwaukee section. The course was for line personnel and was the third phase of a program which included one series for executives and managers and another for supervisors and foremen.

Frank Milauc

RADFORD-ROANOKE . . . Feb. 22, this newcomer to the family of ASQC sections had its charter presentation meeting at the Hotel Roanoke in Roanoke, Va.

Due to poor weather conditions, David Chambers was unable to make the trip to present the charter; however, R. C. Rhodes, section chairman, accepted the section charter. A meeting was then held after the dinner, and each committee chairman outlined his group's planned activity for the coming year. Present plans call for a management dinner, a Ladies' Night, and a section picnic.

The section has membership representation in practically all of the Roanoke Valley's main industries, including General Electric Company of Salem and Lynchburg, Va.; Hercules Powder Co., Radford, Va.; Yale and Towne, Salem, Va.; Electro Tec, Blacksburg, Va.; Poly-Scientific, Blacksburg, Va.; Rubatex, Bedford, Va.; Celanese Fibers Co., Narrows, Va.; Westinghouse Corp., Staunton, Va.; Reynolds Metals, Grottoes, Va.; Du Pont, Martinsville, Va.; Inland Motors Corp., Radford, Va.; West Virginia Pulp and Paper, Covington, Va., and IT & T, Roanoke, Va.

The section goal is to enroll all major industries in the Valley so that a wide variety of QC functions will make the section a diversified one — which would make for interesting meetings in the future.

J. F. LaRocco

RHODE ISLAND . . . This section was engaged in a hot discussion on how to increase QC without additional quality dollars being expended. Out of this discussion came the question "who controls quality anyway?" We were fortunate to have an expert to arbitrate that question. A vice-president of ASQC, as a matter of fact, Warren Purcell, who spoke to the section on Feb. 16. His article, "Who Controls Quality — And How?" in the October 1958 issue, *IQC*, was an excellent basis for answering our question.

The Statistical QC Course II sponsored by our section, in conjunction with the University of Rhode Island, is in full swing. According to our education chairman, Bob Rumazza, 24 students are enrolled.

Paul K. Moffat

ROCHESTER . . . May 20, the food and allied industries sub-group will hold their annual outing at the Happy Acres Country Club . . .

May 16, joint meeting of the RSQC and ASQC, our final business meeting of the year . . .

Feb. 7, the technical sub-group heard Dr. Milton E. Terry, Bell Telephone Laboratories, Murray Hill, N.J., present an interesting paper.

At the February joint meeting with the gage and measurement sub-group, Richard E. Roeger, Cleveland Instrument Co., presented "Electronic and Electric Gaging."

Al Rickmers

ROCKFORD . . . May 18, Holiday Inn, "Computers and Quality Control" by E. Varnum, director of research, Barber Colman Co., Rockford, Ill. . . .

This is the last scheduled meeting until September, 1961. Training sessions which have been conducted before our regular meetings will be concluded at this time. They will be resumed in September.

Arvid R. Bloom

ST. CHARLES . . . The February meeting was held at the Tally-Ho Restaurant near West Chicago, Ind. The afternoon seminar moderated by David Fyffe on "Vendor Certification" was well received. While the attendance was not as good as expected, the interest was very high.

After a roast beef dinner, a short business meeting was held which was followed by a talk by Ellis Elder, QC manager, Television plant, Admiral Corp., entitled "Practical Reliability Studies."

Mr. Elder stressed the importance of starting your reliability program with a firm foundation followed by a running measure of how well you are progressing and if you are reaching your goals. Slides were used to show the improvement in reliability of small receiving tubes over the past few years at Admiral. The May meeting will feature a talk by James Monsma, IBM, entitled "Automatic Data Processing for Quality Control." This will be the last regular meeting of the current season.

Ellis Elder

ST. PETERSBURG-TAMPA . . . Feb. 13, Morrison's Imperial House . . . 100 in attendance heard "Human

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SECTION CALENDAR (MAY 1 TO JUNE 10)

SECTION	DATE	PLACE	TIME	SUBJECT	SPEAKER
Akron-Canton	May 19	Firestone Country Club	7:00 p.m.	Ladies' Night	To be announced
Albany	June 1	Hot Shoppe	4:30	Inspector vs. QC	Debate
			8:00	The "V" Notch Control System	D. S. Holmes, General Electric Co.
Allentown-Bethlehem	May 10	Hotel Traylor, Allentown, Pa.	8:00	QC and Operations Research	F. E. Grubbs, Aberdeen Proving Grounds, Md.
Battle Creek-Kalamazoo	May 13	Western Michigan University Center	9:00 a.m.	All Day Forum	Six speakers plus a luncheon speaker
	May 18	Anchor Inn, Gull Lake, Mich.	7:00 p.m.	Ladies' Night	Knight D. McKesson, Public Relations, Lansing, Mich.
Buffalo	May 15	Foxhead Inn	6:30	Operations Research & Quality Control	Paul S. Olmstead, Bell Telephone Laboratories, Whippany, N.J.
Charleston	May 9	To be announced	6:30	Leading a Colorful Life	Frederick T. Simon, Union Carbide Chemical, Charleston, W. Va.
Chicago	May 17	Furniture Club of America	6:00	Joe Lisy Award Dinner	To be announced
Cleveland	May 5	Cleveland Engineering and Scientific Center	7:30	See How the Baby Has Grown	Ed. Schrock, American Radiator & Sanitary Corp., Baltimore, Md.
Columbus	May 17	Westinghouse Electric Co.	8:00	Reliability Evaluation of a Weapon System	R. C. Draudt, chief QC analyst, North American Aviation, Inc., Columbus Division
Corning-Elmira	May 9	Baron Steuben Hotel, Corning, N.Y.	6:30	To be announced	Mayor Edward Moores, Elmira, N.Y.
Dallas-Fort Worth	May 18	Circle C Steak House, Grand Prairie, Texas	8:00	Three Applications of Analytical Techniques and Experimental Design	Roger W. Anderson, Texas Instruments, Inc., Dallas, Texas
Dayton	May 4	Van Cleve Hotel	6:30	To be announced	J. Y. McClure, president, ASQC
Greater Detroit	May 20	Paris Room, Statler-Hilton Hotel	6:00	Annual Dinner Dance	Lyle Carlyle and his Orchestra
Evansville-Owensboro	May 13	Evansville, Ind.	6:30	Ladies' Night — Personality Through Handwriting	W. Greer, Mead Johnson & Co., Evansville, Ind.
Hamilton-Middletown	May 3	Eaton Manor, 1892 Dixie Highway, Hamilton, Ohio	6:30	Some Aspects of Operations Research	Oscar A. Hoffman, Champion Paper and Fibre, Hamilton, Ohio
Hamilton, Ont.	May 11	Harding Carpet Co., Brantford, Ont.	8:00	Plant tour	To be announced
Harrisburg	May 3	Hershey Chocolate Corp., Cocoa Inn, Hershey, Pa.	7:30	Ladies' Night — Plant tour — QC of Hershey Chocolate Products	E. W. Meyers, Hershey Chocolate Corp., Hershey, Pa.
	June 7	Mt. Joy Legion, Mt. Joy, Pa.	6:30	Annual Picnic and Installation of Officers	.....
Reading Subsection	May 2	Abraham Lincoln Hotel	7:15	The Advantages of SQC	Miss Bonnie Small, Western Electric Co., Allentown, Pa.
Hartford	May 9	Nutmegger House	6:30	Between Ether & Earth in QC	Dorian Shainin, Rath & Strong Inc., Boston, Mass.
Kansas City	May 18	Elks Club, 19 E. Armour	7:00	Annual Business Meeting	.....
Kankakee-Joliet	May 2	Kankakee	6:30	Panel discussion and election	.....
Lexington	May 18	Adams Restaurant	7:00	Industrial Experimentation	S. B. White, Westinghouse Corp., Youngwood, Pa.
Lima	May 9	Milano Club, Lima, Ohio	6:30	Annual Mardi Gras — Installation of Officers	.....
Los Angeles	May 23	IAS Bldg.	6:30	Panel—Garrett Corp.	Several
Memphis	May 15	To be announced	....	A Reconsideration of the Variables Control Chart with Special Reference to the Chemical Industries	Richard A. Freund, Eastman Kodak Co., Rochester, N.Y.
Mid-Hudson	May 2	Hotel DiPrima, Highland, N.Y.	8:00	Universals of Management	Dr. J. M. Juran, Consultant, New York, N.Y.
	June 6	Hotel DiPrima, Highland, N.Y.	8:00	Social Meeting	.....
Minnesota	May 16	Holiday Inn	6:30	Annual Business Meeting	.....
Montreal	May 10	Ecole Polytechnic	8:15	The Mechanics of Reliability	A. B. Oxley, Canadair Ltd., Montreal, Canada
Muncie	May 18	.....	6:30	Ladies' Night	.....
Greater Muskegon	May	Stern's Restaurant	6:30	Joint meeting with Muskegon Manufacturers Association	.....
Northeast Tennessee	May 9	Bristol, Tenn.	6:00	Planning for Incoming Material Control	Chester Gadzinski, Raytheon Co., Waltham, Mass.
Omaha-Lincoln	May 10	Lincoln	7:00	Mathematics of SQC	Professor John Birch, University of Nebraska
	June 9	Omaha	7:00	Ladies' Night — SQC in Health	Maldon Crabill, Omaha-Douglas Health Dept.
Parkersburg	May 17	Chancellor Hotel	6:30	Statistical Cost in the Paper Industry	C. E. Noble
Pensacola-Mobile	May 11	Brookley AFB, Alabama	4:30	QC Laboratories	Malcolm A. White, Mobile Air Materiel Area. Brookley AFB, Alabama
Philadelphia	May 11	Germantown Cricket Club	6:15	QC in the Clothing and Textile Industries from the Standpoint of a Military Buyer	Major Harlan Tucker, Military Clothing and Textile Supply Agency
Pittsburgh	May 16	Downtown YWCA	6:30	Ladies' Night	Mrs. Marvis Carroll, General Foods Research Center, Tarrytown, N.Y.
Pittsfield	May 17	Stanley Club	8:00	Metrology — Standard Gage & Measurement Control	J. L. Bolster, W. B. McCallum
Portland	May 13	Sheraton-Portland Hotel	9:00 a.m.	Management Workshop Conference	Dr. J. M. Juran, Consultant, New York, N.Y.
Rhode Island	May 18	Engineering Society Bldg., Providence, R.I.	8:00 p.m.	Experimental Designs	Dr. A. W. Wortham, Texas Instruments Inc.
Rochester	May 16	Chamber of Commerce Bldg.	6:15	Business Meeting	.....
Rockford	May 18	Holiday Inn	7:00	Computers and QC	E. Varnum, Barber Colman Co., Rockford, Ill.
St. Charles	May 16	Tally-Ho Restaurant, West Chicago, Ind.	5:30	Automatic Data Processing for Quality Control	James Monsma, IBM
St. Petersburg-Tampa	May 15	St. Petersburg College	8:00	What is a QC Engineer?	Bill Fenn, General Electric Co., St. Petersburg, Fla.

San Bernardino	May 17	Mural House Restaurant Ontario, Calif.	7:00	Non-Destructive High Speed Inspection	S. Zarcoff, Az.sa Plant, Aerojet General Corp.
San Diego	May 8	Sands Hotel, Clairmont Mesa Blvd., Highway 395	7:00	The Man in the Shop Speaks	Panel members representing Ryan, Rohr, Solar and Convair
Seattle	May 9	Benjamin Franklin Hotel	7:30	Education Night	C. Arnold and D. Carlton
Syracuse	May 21	Turners	6:30	How to Make Quality Count in Your Plant	Harry O. Hehner, Monsanto Chemical Co. St. Louis, Mo.
Toledo	May 13	M&S Cottage, Devils Lake, Mich.	10:00 a.m.	Annual Picnic	
Toronto	May 10	Canadian General Electric Co.	8:00 p.m.	Practical Application of SQC in the Chemical Industry	R. Vance Ward, Canadian Industries, Toronto, Canada
	May 31	To be announced		Annual meeting and buffet supper	Reports of various committees
Utica	May 18	Nofri's Restaurant	6:00	Process Control and Reporting	C. J. Hawkes, Eastman Kodak Co., Rochester, N.Y.
Washington, D.C.	May 17	GSA Auditorium	8:00	Achieving Quality, Including Reliability At a Minimum Cost	Dr. Harry Romig, Operations Research, Inc., Los Angeles, Calif.
Western Massachusetts	May 9	Sheraton Motor Inn, Springfield, Mass.	6:30	Quality Control — Its Own Best Salesman	W. D. Parker
Worcester	May 18	Worcester Polytechnic Institute	7:00	$ Value of Quality Control	Edward W. Armstrong, Simonds Saw/Steel Co., Fitchburg, Mass.
Youngstown	May 4	Astoria Cafe	6:30	Pecularities of American Presidents	William Pringle, East Ohio Gas Co.

RIT Courses and Applications Seminar

Several outstanding faculty members will serve on the staff for the 18th annual Statistical Quality Control Intensive Courses for the Chemical and Processing Industries June 12-29 at Rochester Institute of Technology, Rochester, N.Y.

They are Richard S. Bingham, Jr., supervising engineer, The Carborundum Co.; Richard Freund, staff consultant, Eastman Kodak Co.; William C. Frey, head of statistical service dept., Bristol-Myers Co.; Fred C. Leone, director, statistical laboratory, Case Institute of Technology; Prof. Albert D. Rickmers, statistics lecturer, Rochester Institute of Technology.

Also, Leonard A. Seder, Quality Control Consultant, Malden, Mass.; William L. Tronzo, QC engineer, Bausch & Lomb, Inc.; Frank W. Wehrfritz, QC director, Esso Standard Oil Co.; Grant T. Wernimont, management systems development, Eastman Kodak Co.; and Dr. Mason E. Wescott, professor of statistics, Rutgers • The State University, New Brunswick, N.J.

Industrial Statistics and Quality Control, fee for which is $225, will run from June 12-21. The final two days of the seminar will be devoted to the special Applications Seminar, which will be included in the total course cost. Those attending the Design of Experiments seminar from June 22-29, fee for which is $175, may also attend the special Applications Seminar for an additional fee of $50, if they so desire.

Questions regarding housing, detailed information on either or both courses, and registration procedures may be directed to Harold M. Kentner, director, Extended Services Division, Rochester Institute of Technology, Rochester 8, N.Y.

An Invitation to Join

The Chemical Division

All phases of industry, including research, development, control, production, sales and management, require aids in obtaining information, analyzing data and forecasting future action.

Statistical methods provide such aids.

The Chemical Division, ASQC, was organized in 1953 to promote the use of statistical techniques in the chemical and allied processing industries and has grown rapidly since that time.

The Chemical Division has assumed responsibility for and participated in ASQC activities such as:

"Co-sponsorship of the annual Stevens Institute, a Symposium on "Statistical Methods in the Chemical Industry."

Annual Chemical Division Technical Conference.

Suggesting topics and speakers for ASQC meetings, both national and local.

Co-sponsorship of short courses in EVOP (a practical form of response surface analysis) and other new techniques.

Liaison with educators and technical organizations in statistical training for chemists and engineers.

Promoting the appreciation and use of statistical techniques by management.

Encouraging publication of papers on new statistical methods and their practical use. The Chemical Division is responsible for *Technometrics*, a joint publication of ASQC with the American Statistical Association dealing with statistical theory and application in the physical and engineering sciences.

Members in the Chemical Division participate in a vital, growing movement within the chemical industry. They are in a position to guide this growth to provide themselves and their companies with the information and help they need.

Membership in the Chemical Division affords an excellent opportunity to discuss problems with friends in similar fields. You will receive the CD *Newsletter* with highlights of the Division and its members and selected reprints of articles and papers.

Members of ASQC may affiliate with the Chemical Division by forwarding one dollar for annual dues, with the attached membership blank, to ASQC Headquarters.

ASQC, 161 W. Wisconsin Ave. 5-61
Milwaukee 3, Wis.

Enclosed is $1.00 dues for 1961-62 membership in the Chemical Division, ASQC.

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Factors in Space Age Conflict" by Dr. R. A. Ibison, Electronic Communications, Inc.

The section is currently conducting a QC training course in Problem Solution.

H. Goldberg

SAN BERNARDINO . . . May 17, 7 p.m., Mural House Restaurant, Ontario, Calif., "Non-Destructive High Speed Inspection" by Sam Zarcoff, head, special processes, quality control, Azusa plant, Aerojet General Corporation . . .

Gene A. Williams

SAN DIEGO . . . Feb. 13, a continuation of this section's run of highly successful dinner meetings . . . This meeting marked the Ninth Anniversary of the San Diego section and 125 members and guests joined in honoring 18 of the 24 charter members who are still members in good standing.

The education portion of the evening was deftly handled by A. S. Billings, QC director, Ryan Aeronautical Co., serving as moderator. F. Cox and J. Orr, both of Ryan Aeronautical, gave a very informative presentation on "High Energy Forming of Space Age Materials." The speakers were very effective, using both slide projectors and display items to supplement their spoken words.

May 8, Sands Hotel, Clairmont Mesa Blvd., Highway 395, 7 p.m., "The Man in the Shop Speaks" by panel members representing Ryan, Rohr, Solar and Convair.

L. I. Frederickson

SEATTLE . . . Training sessions of one-hour prior to regular monthly meetings were initiated during February. Al Bartlett, Boeing Airplane Co., started the series on Feb. 14 with an introduction to the general area of capabilities and limitations of statistical techniques. The series of sessions will cover many facets of statistical QC.

The section is planning a One Day Conference during the latter part of May at the University of Washington. Inspection will be the hub of the conference. Some of the spokes will be inspection, process average, and QC.

The morning session will be a general presentation of inspection. The afternoon sessions will be group discussions of the spokes.

D. C. Lillis

SYRACUSE . . . Feb. 20-25, our section participated in "Engineers' Week" activities, which were capped by an afternoon symposium and banquet at which ASQC president, J. Y. McClure, presented "Problems of Professional Status."

Feb. 3, Klare L. Teegarden, section chairman, spoke in Ithica, N.Y., on "Package Weight Control" during the Statistical QC and Instrumentation Workshop for the Food Industries. Following the talk, he participated in a workshop period designed especially to give practice in applying QC techniques to practical problems.

Lee Huyler

TOLEDO . . . Feb. 2, it was cold and windy but a pretty fair crowd drove to Clyde, Ohio, for a plant tour of the Whirlpool Corp. . . . Those who attended were rewarded for getting out on a winter night . . . Steve Horvath's remarks were very interesting . . . A short break in the tour was planned by the Whirlpool people while refreshments were served in the company cafeteria . . .

May 13, through the courtesy of Keith L. Lewis, section members and their wives will again be guests of the M & S Manufacturing Company of Hudson, Mich., at their lovely cottage on Devils Lake. At this picnic, the outgoing chairman, Joseph A. Ivan, and his officers will take a well-earned retirement and the newly elected officers and directors will be installed.

Carwin L. Elwick

TORONTO . . . Feb. 22, new officers for the 1961-62 season are chairman — Jim Butler, department manager, Don Mills plant, IBM; vice chairman — Saul Brodsky, QC engineer, Radio and Television Department, Canadian General Electric Co. Ltd.; secretary — Vern Pringle, product engineer, Crouse-Hinde of Canada Ltd., and treasurer — George Milne, QC specialist, Carboly plant, Canadian General Electric Co. Ltd. . . .

After the election, Ross W. Jollow, service representative, Electronic Data Processing Division, Honeywell Controls Ltd., Toronto, rounded out the evening with the showing of a film and slides in conjunction with his excellent address on "The Computer in Production."

George Culver

UTICA . . . May 18, Nofri's Restaurant, "Process Control and Reporting" by Cuyler J. Hawkes, Eastman Kodak Co., Rochester, N.Y.

The talk considers the performance of successive units of product to be the result of a "process" (parts, assembly, adjustment, etc.); the usual statistical techniques for process analysis, improvement and control, may be applied.

The paper also describes applications of IBM equipment to the presentation of charts and to the reporting of control chart data for information feedback purposes.

Feb. 21, the section joined with other Professional Engineering Societies in the Mohawk Valley in recognition of National Engineering Week. A banquet was held at Twin Ponds Golf and Country Club. J. Bridges, director of defense research and engineering at the Pentagon, was the speaker for the evening.

D. F. Yeaton

WASHINGTON, D.C. . . . Feb. 15, Dr. Morris H. Hansen, Bureau of the Census, made an outstanding presentation on QC in the 1960 Census of Population and Housing.

Dr. Hansen explained how an attempt was made to control some 170,000 enumerators hired for two or more weeks to complete the national census.

Those in attendance were amazed at the independent verification scheme developed and used in the coding operations.

Statistical QC was maintained in the microfilming and Fosdic process. Fosdic — Film Optical Sensing Device for Input to Computers — eliminates the card to tape process previously used in this tremendous data processing job.

Areas requiring more research and investigation were pointed out with such optimism that perhaps some of the problems will soon be solved.

Eugene Tucker

WESTERN MASSACHUSETTS . . . May 9, it is expected that W. D. Parker will be our guest speaker for this meeting . . . His topic will be "Quality Control — Its Own Best Salesman" . . .

It is tentatively planned to have a management representative from the Springfield plant, Westinghouse Corp., to act as host for the evening and introduce the speaker.

The meeting will be held at the Sheraton Motor Inn, Springfield, Mass., and will begin at 8 p.m., following a dinner that is to be served at 6:30 p.m. This is the last regularly scheduled meeting until September.

Feb. 14, A. E. Aubin, QC manager, Underwood Corp., Hartford, Conn., with "Assembly Control of Complex Assemblies" which covered the inspection and analysis of inspection data on the assembly of complex products.

He outlined a system which covered the many inspection points that must be controlled during a complexed assembly. His discussion included inspection planning, inspector training, feed-back of results, data analysis, and reporting.

Introducing Mr. Aubin was Sidney Low, assistant manager, manufacturing engineering, Gilbert and Barker Manufacturing Co., Springfield, Mass., who acted as host for the evening.

Alan J. Donnelly

UNIVERSITY OF WESTERN ONTARIO . . . Feb. 16, a dinner meeting was held with the Society of Industrial Cost Accountants at the YMCA, London, Ontario, Can.

After dinner, W. R. Leal, assistant secretary and controller of Eaton Automotive Products Ltd., read a number of papers to introduce the cost accountants to QC. Two films were shown on QC and R. B. Statts, quality supervisor, Wolverine Tube Ltd., spoke on "Quality Costs." He suggested that cost accountants could assist QC by reporting quality costs on a regular basis.

Feb. 22, Kitchener, "The Use of Statistics in Business Decision Making" by Dr. W. R. Hossack . . .

WORCESTER . . . Feb. 16, Ladies' Night, Nick's Grille, Worcester, Mass. . . . Corsages were given to the ladies in attendance, and the couples enjoyed themselves at a social hour prior to the dinner . . .

Following the dinner, a very entertaining program was given by Ben Fogg of the Four Season's Travel Agency.

Mr. Fogg gave an illustrated talk entitled "So Small My Island," a travelogue on the Japanese Islands.

He also showed an interesting display of cloths and lacquered articles purchased on his trip to the Orient.

May 18, Edward W. Armstrong, Simonds Saw and Steel Co., will be guest speaker . . . His topic — $ Value of Quality Control . . . This annual Management Night will be held at Worcester Polytechnic Institute . . .

Daniel J. Burda

YOUNGSTOWN . . . Feb. 3, Astoria Cafe, Jay O. Mack, United States Steel Corp., with "Steel Mill Quality Control."

Mr. Mack is chief steel production metallurgist at the Fairless plant.

May 4, Astoria Cafe, Ladies' Night, "Pecularities of American Presidents" by William Pringle, secretary of the East Ohio Gas Co. . . .

Charles Wirebaugh

Significant Differences

. . . ALLENTOWN-BETHLEHEM — **Ken Stephens,** Western Electric Co., recently spoke to a group of engineers from the Dixie Cup Company at their plant in Easton, Pa. The topic — Quality Control Techniques.

. . . BATTLE CREEK-KALAMAZOO — On Feb. 7, **Robert Muir,** chairman of the NSMPA quality control committee and QC director, Lundberg Screw Products Co., Lansing, Mich., presented the "Suppliers' Viewpoint" of the quality problems arising between the customer and supplier at the Lake Erie District of the National Screw Machine Products Association, Cleveland Engineering Society, Cleveland, Ohio.

. . . CLEVELAND — Dr. **Fred C. Leone,** Case Institute of Technology, has been appointed associate editor of *Technometrics.* Dr. Leone is past chairman of the Cleveland section and this year has been advisor to the program and speakers committee.

Edward Adams is now project engineer with Merriam Instrument Co., Cleveland, Ohio.

On Feb. 7, members **Ray Marks,** Ford Motor Co., and **Steve Combs,** Thompson-Ramo-Wooldridge, were panel members at the local National Screw Machine Products Association meeting. The panel discussed the topic — "Supplier and Customer Relations." Program chairman **Ted Ursu** arranged for Messrs. Marks and Combs to be on the panel.

. . . DALLAS-FORT WORTH — **Don Blosser** has decided to take the advice to "Go West Young Man." He has accepted an assignment with Aerojet General, Sacramento, Calif. Don will be missed around section activities.

Herb Epstein, ASQC Fellow, is sporting a new office and title. He recently moved into Vought Electronics' new building and is manager of reliability and quality assurance.

. . . GREATER DETROIT — **George R. Garske** is the newly appointed QC engineer at Chevrolet-Saginaw Transmission Division.

George W. McDermott, formerly Senator from Madison County, Ind., attended the Automotive Division Conference and tells us he has returned to work for Delco-Remy Division.

Edward Richards has moved to Napoleon, Ohio, to be plant manager of the Clevite Harris plant.

. . . EVANSVILLE-OWENSBORO — **Ed Stiles,** formerly QC manager, Evansville Division, Bucyrus Erie, has been promoted to production manager. Ed is a senior member of ASQC and has been on the speakers list in past years.

. . . HARTFORD — **Kenneth Martin,** section chairman and quality manager at Veeder-Root, Inc., has been nominated for ASQC director from New England.

Kenneth A. Merz has been appointed director of engineering of the Air Moving Division of the Torrington Manufacturing Co., Torrington, Conn., producer of fans, blower units and wire-forming machinery. Mr. Merz will be responsible for setting standards for all air moving engineering at the firm's plants in Torrington,

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Conn., Van Nuys, Calif., Rochester, Ind., and Oakville, Ontario. For the past year, Mr. Merz has been engineering manager, Air Impeller Division, Torrington, Conn.

. . . LEXINGTON — **Roy Harney,** assistant chief of quality assurance, Lexington Signal Depot, has been awarded an outstanding performance certificate by the USDA.

. . . LOS ANGELES—VALLEY SUBSECTION—**Chuck Wing** has been promoted to staff assistant to the head of the quality assurance branch of the California Division, Lockheed Aircraft Corp.

. . . MID-HUDSON — **William Tuceling** has been appointed chairman of the section's One Day Seminar to be held in early September. Mr. Tuceling is a technical assistant to the quality manager at IBM, Poughkeepsie, N.Y.

. . . MINNESOTA — **E. O. Joesting,** manager of central quality control for the Tape Division of Minnesota Mining and Manufacturing Co., has been named chairman of the 3M Technical Forum.

The Forum, an organization of some 150 delegates and alternates representing some 1,600 technical persons in the 3M Company, directs educational programs, scientific meetings, and other professional activities for technical employees.

Mr. Joesting, a University of Minnesota graduate in chemical engineering, has been with 3M for 19 years.

. . . MONTREAL — **Miss Isobel Loutit,** Northern Electric, has been appointed chairman of the section's All Day Forum for 1961. Miss Loutit has been active in the QC field for 13 years and has a B.A. in mathematics from the University of Manitoba.

. . . NORTHEAST TENNESSEE — **J. T. Johnson**, QC manager, Raytheon Co., and section chairman, was moderator on two TV programs in connection with National Engineers' Week. The first program was on WCYB TV, Channel 5, on Sunday, Feb. 12. The topic for the one-half hour program was "The Challenge." **Dick Hill** and **Bill Morgan** also participated in the program. The second program was held on Feb. 25 on WJHL, Johnson City, Tenn. The topic of this program was "A Career of Opportunity."

These programs have been placed on Kinescope for future showings on TV to high school students. An estimated 35,000 viewers saw the two programs.

Representatives of the AIIE, AIEE, ASME, NSPE, ISA, ASCE and AShE participated with the East Tennessee section, ASQC, during National Engineers' Week. The week's program was concluded with a banquet in Kingsport, Tenn., for all engineers.

One statistical course presented by East Tennessee section and East Tennessee State College is now being conducted for graduate credit. Of the 22 enrollment, seven are members of this section.

Dr. **Hubert Hill,** Tennessee Eastman, past section chairman, spoke at the February meeting of the section at the University of Tennessee, Knoxville, Tenn. The subject of his talk was "Ten Questions for Experiments."

The East Tennessee section has founded a student branch at Steed College in Johnson City. **Dean Carl Doss** is the branch faculty advisor and is a member of this section. Dr. **Hubert Hill**, **Minter Hayes,** and **Jim Cook** make up the Student Branch advisory committee.

Claire Penton, section member of Magnavox, Greenville, Tenn., attended a reliability symposium at Vanderbilt University.

. . . OMAHA-LINCOLN — Western Electric of Omaha has announced the following promotions:

Ray S. Borgstadt, from department chief, Cable Shop, Omaha, to assistant superintendent, quality control and inspection, Oklahoma City, Okla.

Harold E. Bryan, from department chief, inspection and QC, Lincoln, to department chief, inspection and QC, Columbus, Ohio.

Dean H. Luethje, department chief of engineering, Lincoln, to department chief of engineering, Kansas City.

. . . PARKERSBURG — **George Wulfert** of Carborundum Metals has accepted the position of advance program chairman for the 1961-62 season.

. . . PHILADELPHIA — A basic course in QC principles and practices was started Feb. 23 and will continue through Apr. 27. The course covers one two-hour session a week and is conducted at the Philadelphia QC Center. It was designed for manufacturers in the clothing field.

Members **William Haniman** and **Al Dettore** recently completed a five day executive development program given by the Pennsylvania State University.

. . . PITTSBURGH — **John Hromi** has been transferred to the Gary Works, U.S. Steel. We wish him every success in his new position.

. . . PITTSFIELD — **Richard Powell,** Sprague Electric Co., North Adams, Mass., accepted a position with Transition of Wakefield, Mass., as senior manager of quality control.

Mr. Powell was graduated from Massachusetts Institute of Technology in 1952 with a degree in Electrical Engineering, and is a member of the honorary society, Eta-Kappa-Nu. He entered the U.S. Army Signal Corps., and after completing his hitch, joined Sprague Electric Co., North Adams, Mass., in the research and engineering department. He was promoted from reliability and engineering to his present position as quality reliability engineer.

. . . RHODE ISLAND — **Bob Penman** has been named quality assurance manager of the General Plate Products Group, Metals & Control Inc., a corporate division of Texas Instruments, Inc. Bob was formerly the work simplification coordinator for that division.

. . . ST. CHARLES — Our executive committee met recently to discuss the forthcoming All Day Workshop to be held at Aurora College.

The annual Management Seminar which is usually held in August will be scheduled again during the coming year.

Due to the varied background of education and experience of the participants in our intermediate statistics course, it was divided into two levels and instruction for both groups was provided.

. . . SAN FRANCISCO — **Robert E. McKennan**, assistant chief inspector, Friden, Inc., has joined the State of California Department of Agriculture Bureau of Weights and Measures. He will establish quality control procedures for use in the Bureau's sampling program.

Commander **Robert W. Smiley,** USN, has accepted a speaking engagement for the ASQC Annual Convention in Philadelphia, Pa.

Lew Britton, Ampex Corp., has transferred to Lockheed Aircraft Corp., where he is currently engaged in the Polaris reliability program.

Allen Chop, Lockheed Missiles and Space Division, was injured in an automobile accident Dec. 16. He was enroute to a Polaris Reliability Conference at Cumberland, Md. We are happy to report that he has recovered and is now back to work.

. . . SYRACUSE — **Frank Grimes** has transferred from New Process Gear Corporation to Oberdorfer Foundry Co., Syracuse, N.Y., where he will be a liaison engineer.

. . . WASHINGTON, D.C. — Miss **E. Louise Parker,** who is preparing her master's thesis at New York University on "QC in the 1960 Census," was among the enthusiastic listeners at the presentation Feb. 15 by Dr. **Morris H. Hansen** on "Quality Control in the 1960 Census of Population and Housing."

. . . YOUNGSTOWN — **Charles R. Branfield** has been named general supervisor of QC at Packard Electric Division, GMC. In his new post, Mr. Branfield is responsible for the QC function of receiving inspection and by-products. Mr. Branfield is secretary of the Youngstown section, ASQC.

clinics, conferences, and courses

MAY

. . . **8-10**—Fourth National ISA Power Instrumentation Symposium, LaSalle Hotel, Chicago, Ill., contact H. S. Kindler, Instrument Society of America, 530 Wm. Penn Pl., Pittsburgh 19, Pennsylvania.

. . . **9**—Plastics in the Automotive Industry sponsored by the SPE Detroit section in cooperation with the SPE Plastics in the Automotive Industry Professional Activity Group, contact John A. McPherson, Underground Products Inc., 12801 Inkster St., Livonia, Mich.

. . . **9-11**—1961 Western Joint Computer Conference, Ambassador Hotel, Los Angeles, Calif. Papers on systems, applications and circuitry for both digital and analog computers. Contact C. T. Leondes, associate professor of engineering, Department of Engineering, University of California, Los Angeles 24, Calif.

. . . **11-13—Course on Evaluation and Interpretation of Physical and Chemical Test Methods, Sheraton-Jefferson Hotel, St. Louis, Mo. sponsored by the St. Louis section and the Chemical Division, ASQC. Instructors are John Mandel, National Bureau of Standards, and Grant Wernimont, Eastman Kodak Co. Course fee $100. Contact S. H. Huston, Mallinckrodt Chemical Works, Uranium Division, P.O. Box 472, St. Charles, Mo.**

. . . **11-13**—12th Annual National Conference and Convention, American Institute of Industrial Engineers, Inc., Sheraton Cadillac Hotel, Detroit, Mich. Contact James E. McCartney, 12th Annual AIIE Conference, Rm. 29, 4181 Oakman Blvd., Detroit 4, Mich.

. . . **13—Quality Management Workshop under the direction of Dr. J. M. Juran, sponsored by the Portland ASQC section, contact George E. Mickel, Longview Fibre Co., P.O. Box 7035, Portland 19, Oregon.**

. . . **13—All Day QC Forum sponsored by the Battle Creek-Kalamazoo section, ASQC, in cooperation with Western Michigan University, at the University Center, Kalamazoo, Mich. Two parts will cover engineering and research and administration and supervision. Contact Peter F. Koets, Allen Electric Equip, 2101 N. Pitcher St., Kalamazoo, Mich.**

. . . **13**—Employee Training program, Management Center, Marquette University, Milwaukee, Wis., for the entire supervisory and management team, contact Management Center, Marquette University, Milwaukee 3, Wis.

. . . **14-17**—Spring Meeting, National Fluid Power Association, The Greenbrier, White Sulphur Springs, W. Va. Contact NFPA, 5595 N. Hollywood Ave., Milwaukee 17, Wis.

. . . **15-26**—Basic QC Course for the Textile Industry, North Carolina State College, Raleigh, N.C. Contact David B. Stansel, North Carolina State College of Agriculture and Engineering, Division of College Extension, P.O. Box 5125, Raleigh, North Carolina.

. . . **18-19**—Quality Control's Role in Industry, Industrial Engineering Institutes, Memorial Union, Iowa State University, Ames, Ia. Contact Engineering Extension, Iowa State University, Ames, Ia.

. . . **22-26**—Annual Conference of the Society of Photographic Scientists and Engineers, Arlington Hotel, Binghamton, N.Y. Contact SPSE, Box 1609, Main Post Office, Washington, D.C.

. . . **22-27—Northeast Reliability Training Course, Sheraton Inn, Syracuse, N.Y. sponsored by the Electronics Division, ASQC, and the Institute of Radio Engineers. Registration fee of $225 will cover cost of course materials, lunches and one dinner. Contact Mrs. N. J. McAfee, 2106 Tucker Lane, Apt. A-8, Baltimore 7, Md.**

. . . **25**—Third Annual Western Systems Conference, Statler-Hilton Hotel, Los Angeles, Calif., sponsored by the executive council of six Southern California Chapters of the Systems and Procedures Association, contact Leonard M. Grimes Jr., registration chairman, Golden State Mutual Life Insurance Co., P. O. Box 2332—Term. Annex, Los Angeles 54, Calif.

JUNE

. . . **5-7—15th Annual Convention and Exhibit, American Society for Quality Control, Hotel Sheraton, Philadelphia, Pa., see pages 37-44. this issue.**

. . . **5-7**—Second Annual Manufacturing Supervisors Short Course—Management Games—Statistical QC—Linear Programming" sponsored by Auburn University, Auburn, Ala., contact E. R. Ashworth, Department of Industrial Management, School of Engineering, Auburn, Ala.

. . . **5-8**—International Instrument-Automation Conference, Royal York Hotel, Toronto, Ontario, Canada, will cover measurement, data processing, and automatic control, sponsored by ISA, contact H. S. Kindler, Instrument Society of America, 530 Wm. Penn Pl., Pittsburgh 19, Pa.

. . . **5-9**—Basic QC Course for the Graphic Arts Industry, Rochester Institute of Technology, Rochester, N.Y., contact Harold Kentner, Director, Extended Services, RIT, Rochester, New York.

. . . **5-16**—Intensive course in Work Design sponsored by the Department of Industrial Engineering and University College, the Adult Education Division, Washington University, St. Louis, Mo. The course will be conducted in the new Engineering Laboratory Building on the campus. Arrangements have been made for participants to be housed in the new, air-conditioned dormitories. Contact University College, Washington University, St. Louis 30, Mo.

. . . **7-17**—Design of Experiments Course, Charles R. Hicks, instructor, Purdue University, Lafayette, Ind., contact Statistical Laboratory, Engineering Administration Bldg., Purdue University, Lafayette, Indiana.

. . . **11-23**—Reliability Institute, University of Connecticut, Storrs, Conn., contact Richard M. Story, Jr., University of Connecticut, Storrs, Connecticut.

. . . **12-21**—Basic QC Course for the Chemical Industry, Rochester Institute of Technology, Rochester, N.Y., contact Harold Kentner, Director, Extended Services, RIT, Rochester, N.Y.

. . . **13**—Fourth Graduate Summer Program of Statistics in the Health Sciences, June 13 through July 28, University of Minnesota. Persons interested in course work in elementary or advanced statistics, vital records, records management, design of experiments, bioassay, sampling, demography, and statistical aspects of nutrition research, genetics, pharmacology and mathematical models are invited to attend. Stipends are available to qualified students. Experts such as Cochran, Cox, Li, Chiang, Bailey, Patton, and others will be teaching. House, food and course fees will be about $300. Contact Biostatistics, 1226 Mayo, University of Minnesota, Minneapolis 14, Minn.

. **13-16**—Cornell University Seminars in Industrial Engineering, Department of Industrial and Engineering Administration of the Sibley School of Mechanical Engineering, concurrent four-day sessions on industrial management, engineering administration, capital investment planning: theory and practice, op-

(Please turn to Page 80)

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Replies to box numbers and copy should be addressed to American Society for Quality Control, 161 W. Wisconsin Ave., Milwaukee 3, Wis. Deadline is 22nd of second month preceding publication.

POSITIONS WANTED

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Age 41, B. Ch. Eng. degree, graduate work in Engineering Administration. Fourteen years comprehensive experience in setting up and managing Quality Control Systems in chemical and film type industries. Please reply to Box 17L1.

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Education and Training Institute
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Quality Control Engineering encompasses the planning, the control, the evaluation, and the reporting of all quality aspects of product from its inception through manufacture or processing to the customer.

While many companies have successful Quality Engineering programs, a preliminary survey indicates that specific documentation as to how the Quality Engineer functioned in each area is rare. The need for a course in Quality Control Engineering is recognized by the Education and Training Institute. However, it appears that development of material for such a course would be a major task.

The General Electric Company has documented a considerable amount of material in the field of Quality Control Engineering, and has been conducting courses for their own engineers in this field. The Company has generously offered its services to the Society, contributing not only the course material but also the services of L. N. Bress, General Electric Consultant in Education, for planning and implementing this program. In addition, GE has offered the services of T. E. Schultz and F. C. McLaughlin as instructors. The fourth instructor will be P. C. Clifford, Director of the Institute. This service is offered by General Electric for only this first course and will not be repeated. The Society has gladly accepted this offer, and the course will be presented June 19 to 23, 1961. Facilities have been arranged at the Hotel Thayer, West Point, N. Y.

Enrollment for this course must be limited to 30 persons, since much of the work will center around case problems and seminars. For this one week, the major objective will be the development of future teachers of Quality Control Engineering. It would appear that qualified personnel with a good knowledge of quality control statistics and quality control procedures could, in a short time, evaluate the material, correlate it with their own organizational structure, indicate how it might need to be adapted to their type of industry and suggest reorganizations and amplifications. From the participants in this course, the Institute hopes to develop task forces to implement an Institute program in Quality Control Engineering.

Applicants will be expected to have a knowledge of statistical quality control as well as experience in Quality Control Engineering work.

Application blanks are available from William P. Youngclaus, Administrative Secretary, ASQC. Applicants are accepted only after evaluation of this application form and will receive written notice of their acceptance. The fee for the course will be $150.

The Institute will consider special fellowship arrangements for full-time university personnel.

QC, Reliability Symposium
Issues Call to Authors

A Call to Authors has been issued for papers to be presented at the Eighth National Symposium on Reliability and Quality Control, Jan. 9-11, 1962, Statler Hilton Hotel, Washington, D. C.

The symposium will be sponsored by ASQC, IRE, AIEE, and EIA.

May 15, 1961, is the deadline for submission of title of paper and an abstract of not more than 800 words. The letters and spaces in the title of the paper must not exceed 50.

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. . . **14**—Plastics in Packaging SPE Regional Technical Conference sponsored by the Quebec section of the international Society at the Sheraton Mount Royal Hotel, Montreal, Quebec. Contact James C. Gillis, RETEC registration chairman, c/o Carlew Chemicals, Ltd., 18 Westminister St., N., Montreal West, Quebec.

. . . **15**—Southern Regional Graduate Summer Session in Statistics, Virginia Polytechnic Institute, Blacksburg, Va., June 15 through July 22. The Virginia Polytechnic Institute, Oklahoma State University, North Carolina State College, and the University of Florida have agreed to operate a continuing program of graduate summer sessions in statistics to be held at each institution in rotation. The session will last six weeks and courses will carry five quarter hours of credit. Not more than two courses may be taken for credit at any one session. The summer work in statistics may be applied as residence credit at any of the cooperating institutions, as well as certain other universities, in partial fulfillment of the requirements for a graduate degree. Courses are statistical methods, sampling theory, applied statistics for engineers and physical scientists; theory I, probability; theory II, statistical inference; theory III, theory of linear hypotheses; non-parametric methods and multivariate methods. A number of courses in advanced mathematics will be available during the summer session. A series of Colloquia involving recent developments in statistical theory and methods will be conducted during the special summer session. Requests for application blanks and for fellowships should be addressed to Dr. Boyd Harshbarger, Head, Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Va.

. . . **19-23—Quality Control Engineering Course sponsored by the ASQC Education and Training Institute with the cooperation of the General Electric Co., at the Hotel Thayer, West Point, N. Y. Since this course will not be repeated, the major objective will be the development of future teachers of Quality Control Engineering. Enrollment has been limited to 30 persons. Applicants will be expected to have a knowledge of statistical quality control as well as experience in Quality Control Engineering Work. Fee $150. Contact ASQC, 161 W. Wisconsin Ave., Milwaukee 3, Wis.**

. . . **19-30**—Probabilistic Methods in the Control of Operations, MIT, contact John I. Mattill, Massachusetts Institute of Technology, Cambridge 39, Mass.

. . . **22-29**—Advanced QC Course for the Chemical Industry, Rochester Institute of Technology, Rochester, N.Y., contact Harold Kentner, Director, Extended Services, RIT, Rochester, New York.

. . . **28-30**—Second Joint Automatic Control Conference, University of Colorado campus, Boulder, Colo., sponsored jointly by ISA, AIChE, AIEE, ASME and IRE. General program chairman is H. M. Paynter, Mechanical Engineering Dept., Massachusetts Institute of Technology.

ASQC Annual Convention

Future Dates

June 5-7, 1961	**Philadelphia**
May 23-25, 1962	**Cincinnati**
May 20-22, 1963	**Chicago**
May 4-8, 1964	**Buffalo**
May 4-8, 1965	**Los Angeles**
June 1-3 1966	**New York**

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- Short History of Standards
- National Bureau of Standards in Relation to United States Standards

TRACEABILITY AND GOVERNMENT REQUIREMENTS
- Traceability of Standards
- Enforceable Standardization for Space Age Requirements
- Mil. Specifications and Government Directives

DERIVATION OF STANDARDS
- Prototype Standards
- Derived Standards
- Classification of Standards:
  - Legal
  - Reference
  - Laboratory
  - Working

HUMAN FACTORS IN STANDARDS
- Interest
- Aptitude
- Integrity

INSTRUMENTATION
- Theory of absolute and comparative measurements

COMPARATIVE INSTRUMENTS
- Use and Limitation of Comparative Instruments
  - Fixed Instruments
  - Mechanical Instruments
  - Electronic Instruments
  - Optical Instruments

ABSOLUTE INSTRUMENTS
- Theory, Application and Limitations
  - Optical Flats
  - Monochromatic Lights
  - Interferometers
  - Automated Interferometers
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- Systematic Errors
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- General Review
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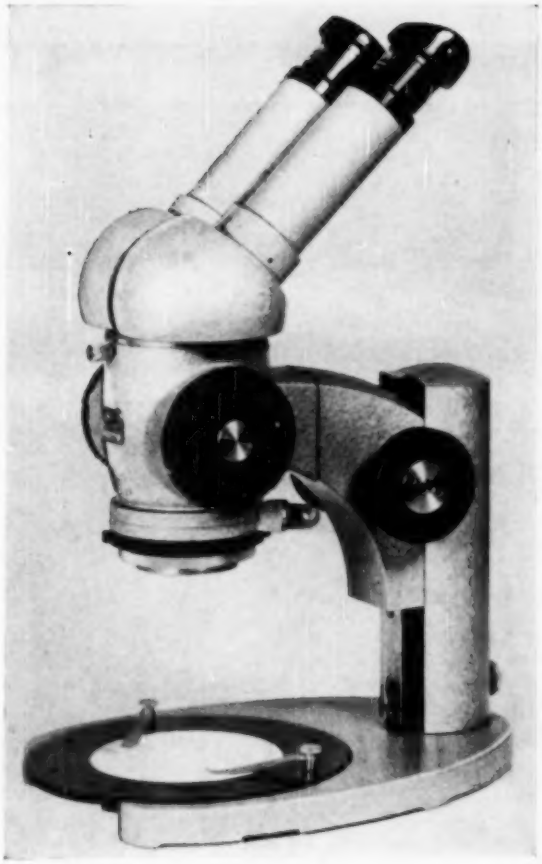

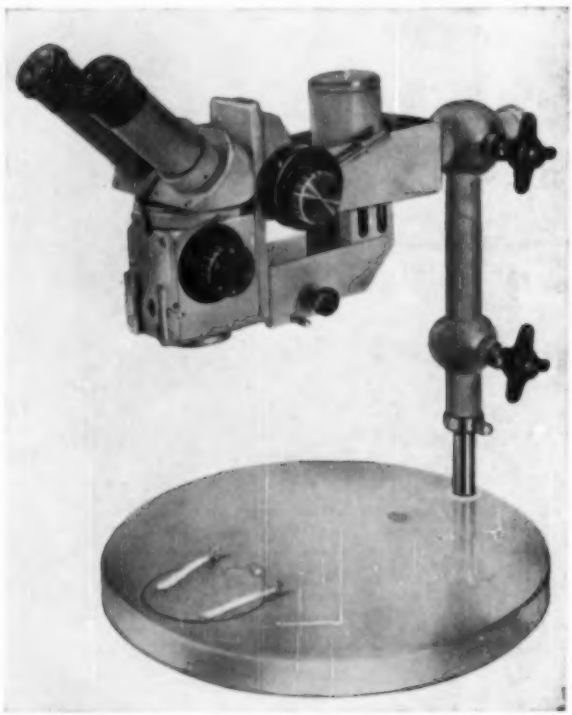

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